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Training of KRPs in Teaching of Science and Technology From Class 6 – 10 for the states of U.P., Uttaranchal, H.P., J&K and Union Territory of Chandigarh

Phase – II (12th - 16th January, 2004) for H. P., J&K, Uttaranchal and U.T. Chandigarh

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Foreword

In the light of National Curriculum Framework for School Education (2000) NCERT brought out new text books for Science and Technology at secondary level Various states are at present busy in revising their own curriculum in the context of this development The states of Jammu and Kashmir, Uttar Pradesh, Himachal Pradesh, Uttaranchal and Union Territory of Chandigarh expressed the desire that their key resource persons (K R P.s) be trained for teaching the new curriculum more effectively In this context, Programme Advisory Committee (P A C.) approved a programme for the training of key resource persons of these states in teaching of science and technology

Dr V P. Gupta, undertook this programme along with his colleagues namely Prof. H C Jain, Dr Animesh Kumar Mohapatra, Dr R.K Parashar, Dr S.V Sharma and Mr Jai Prakash Narayan, and as a first step, identified the topics that are difficult and/or new and need special attention during the training In consultation with Department of Teacher Education, N C E R T New Delhi, training material was developed and was used in the training. Training sessions were organized on these topics and discussions held in the light of making teaching more effective. Dr. V P. Gupta and his team did a commendable job in organizing an efficient and effective teacher education programme I hope the training imparted and the instructional material given to the participants would be useful for further training of the teachers in the state.

January, 2004

Prof. A.B.Saxena
PRINCIPAL

PREFACE

Science is a systematic study and knowledge of natural and physical phenomena. National Curriculum Framework for School Education (2000) describes science as the creative response to the curiosity and capacity to wonder. Development of science has a direct bearing on technology and the society Hence, a need was felt to include the component of technology in the science course at the upper Primary and the secondary stage to emphasise upon the applications of various principles of science to technology in our day-to-day life situations in view of the strong organic linkages between the two. The States Govts. of Jammu & Kashmir, U.P., H P., Uttaranchal and Union Territory of Chandigarh expressed desire for training of KRPs of their states. Hence, this programme was taken up with the objectives of training of KRPs of SIEs/SCERTs/DIETs for teaching of Science and Technology at upper Primary and the secondary stage.

The resource material developed by faculty members of DESM of the institute associated with this programme on ten topics of Science and Technology Textbooks from class 6-10, besides topics like Science and Technology at upper Primary and Secondary Stage in the light of NCFSE (2000), Development of values through Science experiments, Evaluation and Grading and Implications of Research for Science Teaching has been used during this training programme An effort has been made by KRPs to develop some material in the light of their needs

I am thankful to Prof. A. B Saxena, Principal of the Institute for assigning me this project, for providing facilities and for acting as a resource person in this programme. This programme would not have been a success without the tireless efforts of my colleagues namely Prof. H. C Jain, Dr A. K. Mohapatra, Dr R. K Parashar, Dr. S V Sharma and Sh J P. Narayan who discussed various topics with the help of thrilling activities I express my deep sense of gratitude to all of them. Dr. S. C Bhargava, Dr. Sukhvir Singh, Mrs. Ruchi Verma, Sh Ved Prakash Arya, Sh J K Vatsa, Sh. Islam Ahmed and staff of DEE who helped us in Laboratory and group activities deserve my special appreciation. Sh Bishamber Dass ji of DESM and Sh Hussain Ali worked overnight for typing and photocopying the manuscript for which they deserve my special thanks. I acknowledge my indebtedness to authorities of State Govts. of H P., J&K, Uttaranchal and U.T Chandigarh for deputing KRPs in this programme. I am highly thankful to all the Key Resource Persons for having high order interactions with the faculty of the institute and for working overnight to develop material for their state. It is hoped that this training material will be useful to the children scientists to turn them into good citizens of this Nation

(Dr. V. P. Gupta)
Programme Coordinator

January 16, 2004

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Science and Technology at Upper Primary and Secondary Stage in the Light of NCF

Dr. V. P. Gupta

1. Science and Technology

Science is a systematic study and knowledge of natural and physical phenomena National Curriculum Framework (NCF 2000) for school education describes science as the creative response to the curiosity and capacity to wonder The National Policy on Education (1986) clearly emphasized the need of learning of science as a part of general education without compartmentalising into its different disciplines i e why during the last sixteen years science has been taught at the upper primary and secondary stage as a single discipline However, it is now being felt that technology (Science of mechanical and industrial arts) is increasingly influencing our quality of life. The advancement of technology in all areas made it imperative to impart such science education to children, which may clearly bring out the relationship between science, technology and society and help them prepare to live effectively in such a technology based society. Hence, a need was felt to include the component of technology in the science course at the upper primary and secondary stage to emphasise upon the applications of various principles of science to technology in our day-to-day life in view of the strong organic linkages between the two.

Learning of science increases the spirit of enquiry, creativity and objectivity along with aesthetic sensibility. It aims to develop well-defined abilities of knowing, doing and being. It also nurtures the abilities to explore and seek solution to the problems related to environment and daily life situations and to question the existing beliefs, prejudices and practices in society Science concerns itself with the fundamental knowledge of universe,

world and its environment Technology, on the other hand, deals with different ways and means of pressing science into the service of mankind, thus enhancing and improving the quality of human life Moreover, science is universal and its principles and laws could be verified anywhere. The technology takes appropriate shapes depending upon various factors including economic, geographical, social and political conditions The twenty first century citizens will have to acquire the basics of scientific and technological literacy The learners have to understand how basic scientific principles are applied in finding solution to some of the problems in the following fields·

(a) Agriculture

- Quality of soil
- Use of right manure/fertilizer
- Harvesting and conservation of water
- Procurement and development of good quality seeds
- Growing of proper crops and their protection from insects
- Importance and use of weather forecast
- Storage of food grains
- Conversion of food grains into various food products
- Marketing of food products
- Mutual cooperation for getting maximum benefits etc

(b) Energy

- Renewable and non-renewable sources of energy
- Conservation of energy
- Developing and using alternative sources of energy like solar, tidal and wind energy

(c) Health and Nutrition

- How to keep healthy
- Protecting from infectious diseases

- Importance of cleanliness of different parts of body especially teeth, nails, hands, eyes, ears, nose and hair
- Protection of edibles from mosquitoes and flies
- Procurement and harvesting of drinking water
- Making water fit for drinking
- Balanced diet
- Yoga and exercises

Besides the above mentioned fields, the learners will have to appreciate the importance of scientific principles in industry, defence, information processing and many other areas which would help them **discover the relationship between science and technology for acquiring problem solving and decision making skills.**

2. Scientific Process

Science operates through its processes Hence, science teaching is to be different from that of the other subjects Mere question answer method will not be enough. Thinking based upon keen and minute observations is to be generated amongst the learner Teaching learning of science needs to be characterised by focused emphasis on processes of science which may consist of the following steps

- Careful observations
- Sensing of problems
- Making hypotheses (On the basis of observations)
- Literature survey/consulting teachers or and friends
- Identification of a particular problem
- Experimentation for seeking solution
- Data collection and analysis
- Interpretation of data
- Drawing inferences
- Modification of hypotheses (in the light of experimental results)
- Limitations and scope for further studies

In our classroom teaching, we will have to perform activities for removal of misconceptions, if any, develop and strengthen the concepts on the basis of seeing, doing and thinking This will lead to development of one very important value i.e truth besides the other related values of critical thinking and reasoning as shown in fig 1

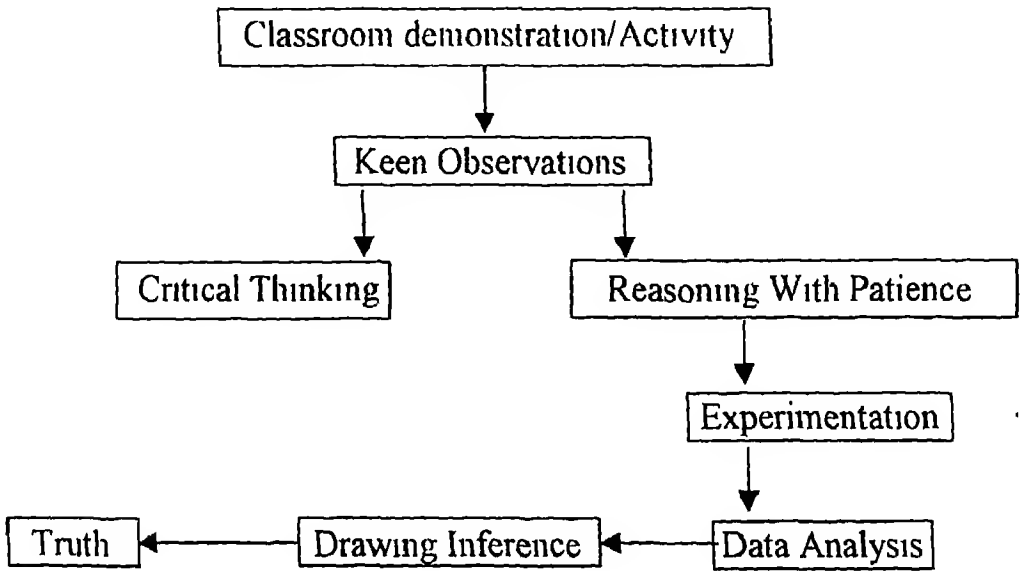

Fig. 1. Development of Values Through Science and Technology

3. Science and Technology at Upper Primary Stage

As already mentioned, NCF has recommended science and technology as a curricular area at the upper primary stage It is envisaged that the science and technology course would aim at promoting scientific and technological literacy among the learners which may enable the learners to (i) Understand the nature of science, (ii) Apply appropriately some of the principles and laws to technology (iii) Enhance capacity to understand values that underline science and technology, (iv) Understand and appreciate the joint enterprise of science, technology and society; and (v) Develop manipulative skills This may also motivate the learners to handle simple apparatus, design experiments, understand the process of science and prepare them to apply their knowledge of science and technology in day-to-day problems

3.1 Objectives

Following are the objectives of science and technology teaching at the upper primary stage

- to expose the children to basic processes of science,
- to understand the processes that underlie simple scientific and technological activities,
- to develop an understanding of some basic principles and laws of science,
- to make the children understand applications of basic scientific principles to solve problems related to daily life,
- to develop the ability to apply appropriate concepts of science to technology,
- to develop measurement and manipulative skills and to encourage use of locally available resources,
- to familiarise the children with life processes, health, nutrition and human diseases,
- to acquaint the children with the technology that abounds in their immediate surroundings,
- to create an awareness of the immediate environment and a need for its protection,
- to make the children recognize the relationship of science technology and society,
- to inculcate in children some of the science and technology related values and
- to provide scientific and technological literacy to learners

3.2 Selection and Organisation of the Content

The syllabus in science and technology has been developed in order to translate the curricular concerns into appropriate content A thematic approach has been adopted to organise the syllabus The themes are the Universe, Our Environment, Matter, Measurement, The Living World,

Energy, Nutrition & Health and Agriculture Most of these themes continue throughout the upper primary stage and continue even upto the secondary stage These themes have been further divided into chapters that contain suitable subject areas and also indicate extent of coverage. The activities envisaged in the textual materials are likely to help the children in learning science more meaningfully The experience of the learners at this stage is also likely to inculcate in them the science and technology related values and also helps them in improving their quality of life It is also visualized that a study of the topics such as nutrition and health, adolescence and common diseases will not only develop an understanding of the subject matter but will also help in removing myths and prevailing superstitions.

3.3 Salient Features of the Syllabus

Some of the salient features of the syllabus are

(i) A fresh look has been given to various concepts at this stage and an effort has been made to present science as a single discipline The syllabus has been so designed as to impart scientific and technological literacy to learners

(ii) Inculcation of the life and experiences of some scientists, including Indian Scientists has been envisaged to inspire the children to pursue the study of science

(iii) While translating the syllabus into textual material, efforts have been made to ensure that science and technology education at the upper primary stage has some values to offer to learners to verifying abilities and socio-cultural background

(iv) Another noteworthy feature of the present syllabus is an attempt to impress upon the young minds the relationship between science, technology and society and a focused emphasis on the various processes of science.

(v) Component of technological applications of some of the scientific principles appropriate at the upper primary stage has been included

4. Science and Technology at Secondary Stage

It is envisaged that the present course in science and technology at secondary stage would facilitate development of essential scientific and technological attitudes and skills amongst children that would form the foundation for their future growth In the present syllabus, an attempt has been made to integrate science and technology especially in areas such as food, health and nutrition, agriculture, energy and industry It is expected that it would help children to relate their knowledge of science and technology in their day-to-day life as also in different areas of national development

4.1 Objectives

During the course of study at this stage, the learners will be able to

- understand the nature of science and technology,
- understand the basic concepts, principles and laws of science,
- apply basic scientific principles in finding solutions to problems related to agriculture, energy, health and nutrition and industry etc.,
- develop problem solving and decision making skills,
- inculcate values that underlie science and technology,
- develop an understanding of the various processes of environment and concern for its conservation and preservation,
- understand and appreciate the joint enterprise of science, technology and society,
- develop rich and satisfying views of the universe,
- develop an attitude which would equip them to continue science and technology education throughout life,
- acquire process skills which form part of the attitude for developing scientific temper, and
- develop certain manipulative skills which are required in day-to-day life situations

Science and technology at secondary stage cuts across traditional subject boundaries and opens itself to issues related to gender equity, culture, languages, poverty, future occupations, environment and observance of small family norms The science and technology syllabus at the secondary stage has been designed under six major themes namely, Matter, Energy, Living World, Natural Resources, Environment and the Universe

In addition to demonstration, experiments and activities included in the text, a separate course on practical exercises has been designed so as to help children inculcate laboratory skills Efforts have been made to include practical exercise from each theme to the maximum extent possible It is envisaged that each student will carry out at least 15 exercises in one academic session

4.2 Time Allocation

At the upper primary stage, 180 periods have been suggested for teaching learning of science in one academic year. At the secondary stage a total of 240 periods (180 for theory and 60 for practicals) have been made available in one academic year

4.3 Suggested Teaching Learning Strategies

Science arouses curiosity Hence, science teaching should be such that it creates thrill in the classroom or outside the class Children at the upper primary stage may be engaged in learning of scientific concepts/principles based upon keen observations of different activities/demonstrations in the class followed by drawing of inferences. The same can be followed at the secondary stage also However, keeping in view the objectives of a given chapter, teachers may adopt a judicious combination of various methods of teaching The teacher may make effective use of variety of teaching learning materials in print and audiovisual forms He/she may gradually develop a resource base of teaching-learning materials by developing innovative demonstrations, scanning available software and surfing through Internet

5. Evaluation

5.1 At Upper Primary Stage

Evaluation has to be an in-built component to assess the achievement of the learners A multi pronged strategy is to be adopted for the assessment of the (i) Learning of scientific concepts (ii) experimental skills and (iii) abilities of the children to understand the technological applications of scientific principles and laws All these would require situation/experiment based tests/experiments

It is envisaged that evaluation in science and technology at the upper primary stage will be comprehensive and continuous Evaluation will comprise tests, unit tests and practical work Development of drawing skills and skills of measurement are also to be evaluated

5.2 At Secondary Stage

At secondary stage also, a continuous and comprehensive evaluation may form an integral part of teaching learning of science and technology The evaluation may be through oral, written and laboratory exercises At every stage, the evaluation may include some component that would help to assess the development of problem solving skills, critical thinking besides desirable attitudes and values

It may be remembered that evaluation at both the stages will comprise tests, unit tests and practical work The final evaluation at the year-end should be a cumulative total of various class tests, unit tests and the tests administered periodically The purpose of evaluation should be both for providing remedial inputs and making assessment of progress of learners Thus evaluation is to be used as a potential tool not only to measure the progress but also to optimize learning of science and technology

6. Strategies for Implementation

The documentation 'Guidelines and Syllabi for Secondary Stage developed by NCERT has suggested practical exercises for class IX & X by the activities/experiments for assessment of the practical work at the upp

primary stage have been left to the teachers Science and technology textbook for class VI, VII, IX and X brought out by NCERT recently consist of a large number of activities, which can be performed in the class/outside the class for understanding and strengthening of the concepts Hence, it would be desirable for the teachers to identify such few activities and develop resource material, which can be used as teaching learning as well as evaluation material Care may be taken to make use of the locally available resource material, which may either be low cost or cost free An exercise on identification and development of values from each chapter of the textbook can also be taken up by the teachers

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माध्यमिक स्तर पर विज्ञान (रसायन) एवं प्रोद्योगिकी का शिक्षण

वेद प्रकाश गुप्ता

विज्ञान शिक्षा के अतर्गत हम अपने चारो ओर पाए जाने वाले पदार्थों एव घटनाओ का क्रमबद्ध ढग से अध्ययन करते हैं। इसमे घटनाक्रमो का सूक्ष्म अवलोकन, समस्याओ की उत्पत्ति, परिकल्पनाए, साहित्य अध्ययन, प्रासगिक समस्या की पहचान, प्रयोगात्मक प्रक्रिया, विश्लेषण, निष्कर्ष, परिकल्पनाओ मे सुधार नई समस्याओ की खोज आदि क्रमबद्ध सोपान हैं। विज्ञान पढने का मुख्य उद्देश्य वैज्ञानिक दृष्टिकोण और वैज्ञानिक विधि विकसित करना है। इसके लिए विद्यार्थियो को खोजने, जाचने, सत्यापन तथा सूक्ष्म अवलोकन के कौशलो का विकास करने के लिए उत्प्रेरित करना आवश्यक है।

प्रस्तावना

रसायन विज्ञान, विज्ञान की वह शाखा है जिसके द्वारा हम अपने चारो ओर पाए जाने वाले पदार्थों की सरचना और उनका एक–दूसरे पदार्थ पर पडने वाले प्रभाव का अध्ययन करते हैं। हमारे चारो ओर पाये जाने वाले और दैनिक जीवन मे उपयोग मे आने वाले अधिकतर पदार्थ रसायन शास्त्र या रसायन विज्ञान की श्रेणी मे ही आते हैं। उदाहरण के तौर पर जिस पैन से हम लिखते हैं, जिस पेपर पर लिखते हैं, पैन की स्याही, मेज, कुर्सी, दैनिक जीवन के लिए रोटी, कपड़ा, मकान, जल और वायु सभी तो रासायनिक पदार्थ हैं। सुबह उठछते ही दात साफ करने के लिए ब्रश और पेस्ट रसायन ही तो हैं। यदि आपको चाय पीनी है तो चाय की पत्ती, दूध और शक्कर आपको रसायन विज्ञान और प्रोद्योगिकी के अनुप्रयोग द्वारा ही प्राप्त होगे। लकडी, कोयला या गैस (एल. पी.जी.) जिसका उपयोग हम भोजन बनाने मे करते हैं, ये सभी पदार्थ भी तो रसायन पदार्थों की श्रेणी मे आते हैं। चाहे जीवन को सुचारू रूप से चलाने के लिए संतुलित भोजन हो, पीने के लिए स्वच्छ जल हो, अपने शरीर को ठड, गरमी और बरसात से बचाने के लिए सूती, ऊनी या सश्लेषित रेशो से बने कपडे हो, चाहे आप किसी छोटे से गाव के एक मकान मे रहते हो या आप महानगर की किसी गगनचुम्बी अट्टालिका मे निवास करते हो, रसायन विज्ञान और उससे सम्बन्धित प्रौद्योगिकी आपके जीवन को सुखमय बनाने के लिए मुख्य भूमिका निभा रहे हैं। एक स्थान से दूसरे स्थान तक जाने के लिए आप स्कूटर, कार, बस, रेलगाडी, हवाई जहाज, समुद्री जहाज से यात्रा करे या आप एन्टार्टिका या मंगल ग्रह पर जाने के लिए विशेष यान का प्रयोग करे, आपके वाहन को चलाने के लिए रासायनिक ईंधन और उस वाहन मे प्रयुक्त उचित प्रौद्योगिकी की आवश्यकता होगी ही। कहने का तात्पर्य यह है कि विज्ञान और प्रौद्योगिकी का हमारे दैनिक जीवन से एक अटूट रिश्ता है। इतने महत्वपूर्ण विषय को पढने, सीखने और इसके बारे मे अधिक से अधिक ज्ञान अर्जित करने की इच्छा होना स्वाभाविक ही होगा।

वैज्ञानिक दृष्टिकोण

जैसा कि पहले उल्लेख किया जा चुका है रसायन विज्ञान, विज्ञान की एक शाखा है। विज्ञान वह विधा है जिसके द्वारा हम अपने चारों ओर पाए जाने वाले पदार्थों और

अपने चारो ओर घटने वाली घटनाओ का क्रमबद्ध ढग से अध्ययन करते है। विज्ञान पढने का मुख्य उद्देश्य वैज्ञानिक दृष्टिकोण और वैज्ञानिक सोच विकसित करना है। क्या सही है और क्या गलत है इसके बीच अन्तर समझ सकना भी एक उद्देश्य है। आइए देखें कि हम विज्ञान का अध्ययन करते हुए वैज्ञानिक दृष्टिकोण या वैज्ञानिक सोच बच्चो मे कैसे विकसित करे ? इसे हम एक बहुत ही सरल प्रयोग द्वारा समझने का प्रयास करेगे।

आप एक मोमबत्ती ले और इसे जलाकर कमरे के एक कोने मे रख दे। अपने विद्यार्थियो से इस जलती हुई मोमबत्ती का अवलोकन करने को कहे। अवलोकन के लिए आप बच्चो को 5–6 मिनट का समय दे सकते हैं। अवलोकन करने पर उन बिन्दुओ को अपनी नोट बुक मे लिखने को कहे। यह प्रयोग अनेक विद्यार्थियो, शिक्षको और शिक्षक–प्रशिक्षको के साथ किया गया है। प्राय यह देखने मे आता है कि किसी भी एक शिक्षक या विद्यार्थी द्वारा अधिक से अधिक 7–8 बिन्दुओ का ही अवलोकन किया जाता है हम सभी विद्यार्थियो से अलग–अलग पूछते हैं, तो अवलोकित बिन्दुओ की सख्या 50 से भी ऊपर हो जाती है। शायद आपका अनुभव भी अपने साथियो या अपने बच्चो के साथ इसी प्रकार का रहा हो। यदि हा, तो हम यह निष्कर्ष निकाल सकते हैं कि हम लोग प्राय अपने चारो ओर की वस्तुओ या अपने चारो ओर घटने वाली घटनाओ का अवलोकन बहुत बारीकी से और ध्यानपूर्वक नही करते। वैज्ञानिक दृष्टिकोण का विकास करने हेतु सबसे पहला पद यही है कि हम अपनी आखे, मस्तिष्क और कान खुले रखे और सूक्ष्म अवलोकन के कौशल का विकास करे।

वैज्ञानिक विधि

जलती हुई मोमबत्ती के सूक्ष्म अवलोकन से अब अनेक प्रकार के प्रश्न, अनेक प्रकार की शंकाए और अनेक प्रकार की समस्याए हमारे मस्तिष्क मे जन्म ले सकती है। हम यह सोच सकते हैं कि यह मोमबत्ती किस पदार्थ से बनी है ? इसकी बनावट क्या है ? इसे हम कैसे बना सकते हैं ? मोमबत्ती किस गति से जल रही है ? एक मिनिट मे कितनी सहति कम हो रही है या एक मिनिट मे इसकी कितनी लम्बाई कम हो रही है ? क्या मोमबत्ती जलने की गति का सम्बन्ध कमरे के तापमान से भी है अर्थात् इस पर मौसम का क्या प्रभाव पडता है ? खुली खिडकी के पास रखने या उससे दूर रखने पर क्या मोमबत्ती के जलने पर कोई प्रभाव पडता है ? मोमबत्ती के जलने से हमे कौन–कौन से पदार्थ मिलते हैं ? इस प्रकार के अनेक प्रश्न आपके मस्तिष्क मे उठेगे और आप इन सभी प्रश्नो का एक–एक करके उत्तर खोजने का प्रयास करेगे। सभी प्रश्नो का उत्तर एक साथ तो मिल नहीं सकता। इसलिए आप किसी एक प्रश्न/समस्या को चुन सकते हैं। आपकी कुछ परिकल्पनाये भी हो सकती हैं और आप शुरू कर देगे अपने मस्तिष्क की एक अनूठी यात्रा जिसमे आप उस प्रश्न/समस्या विशेष से सबधित पाठ्य–सामग्री की तलाश मे अपने पुस्तकालय की ओर चल पडेगे। आपके साथियो एव शिक्षको की सलाह और मार्ग निर्देशन आपकी समस्या के हल मे सहायक सिद्ध हो सकते हैं जो आपको अन्तत· आपके प्रश्न/समस्या के समाधान की ओर ले जायेगे। समाधान हेतु आप कुछ प्रयोग अपने स्वय के हाथो से करना चाहेंगे। एक के बाद एक आप उन परिणामो की पुष्टि हेतु पुनरावृत्ति करना चाहेगे। अब पुन आपको सूक्ष्म अवलोकन की आवश्यकता होगी। प्रयोग करते समय सूक्ष्म अवलोकन और ·फिर विश्लेषण द्वारा प्रश्न/समस्या के समाधान से आप किसी निष्कर्ष पर पहुचेगे और यह होगी सत्य की खोज। इस सत्य के

आधार पर आप अपनी पहले वाली परिकल्पनाओ/पुर्वाग्रह मे सुधार कर सकते है। किसी भी समस्या के समाधान की यह हुई वैज्ञानिक विधि जिसके अपनाने से वैज्ञानिक दृष्टिकोण का विकास हो सकता है। वैज्ञानिक दृष्टिकोण के विकास हेतु अपनाई जाने वाली वैज्ञानिक विधि के विभिन्न पदो को तालिका 1 द्वारा भी समझा जा सकता है। विद्यालयी शिक्षा के लिए राष्ट्रीय पाठ्यचर्या की रूप रेखा 2000 मे भी इन्ही बिन्दुओ की चर्चा की गई है।

तालिका 1

वैज्ञानिक विधि के विभिन्न पद

अपने चारो ओर होने वाले घटनाक्रमो का सूक्ष्म अवलोकन

↓

समस्याओ का जन्म

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परिकल्पनाए

↓

साहित्य अध्ययन (मित्रो/शिक्षको से विचार–विमर्श)

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किसी एक समस्या की पहचान

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प्रयोगात्मक प्रक्रिया

↓

सूक्ष्म अवलोकन

↓

विश्लेषण

↓

निष्कर्ष

↓

परिकल्पनाओ मे सुधार

↓

नई समस्याए और परिकल्पनाये

विज्ञान शिक्षण की वर्तमान स्थिति

यद्यपि प्राथमिक ओर माध्यमिक स्तर पर विज्ञान एक विषय के रूप मे पढाया जाता हे परन्तु रसायनशास्त्र के कुछ पाठो का अध्ययन तो प्राथमिक स्तर से ही प्रारम्भ हो जाता है। अलग विषय के रूप मे रसायन शास्त्र का अध्ययन तो कक्षा ग्यारह से ही शुरू होता है। शुद्ध वायु, शुद्ध जल, सतुलित भोजन, मौसमानुसार विभिन्न प्रकार के वस्त्रो के साथ–साथ हमे धूप, गरमी और बरसात से अपने आपको बचाने के लिए मकान की आवश्यकता भी होती है। जल, वायु, पेड, पौधे, वस्त्र, मकान के विषय मे हम प्राय अपने विद्यार्थियो को प्रश्न उत्तर विधि से ही पढाते है। कुछ प्रश्नो के उत्तर विद्यार्थियो को लिखवा दिए जाते हैं। वे उन्हे रट लेते हैं और विज्ञान शिक्षण हो जाता है। माध्यमिक स्तर पर भौतिक और रासायनिक परिवर्तन, विभिन्न प्रकार की अभिक्रियाए, पदार्थो के सूत्र, उनके पृथक्कीकरण की विभिन्न विधियो, धातु, अधातु, आवर्तसारणी और रासायनिक बधन नामक इकाईयो के भी प्रश्नो के उत्तर लिखवाने मे ही अधिकतर शिक्षक समझते हैं कि उन्होने अपना शिक्षण कार्य अत्यन्त निष्ठापूर्वक किया है। कैसे होगा बच्चो मे इस प्रकार से वैज्ञानिक दृष्टिकोण का विकास। आठवीं कक्षा के बच्चो से जब कुछ यौगिको के रासायनिक सूत्र लिखने को दिए गए जो वे कक्षा 7 मे पहले ही पढ चुके थे तो केवल 35 प्रतिशत बच्चे ही ठीक से सूत्र लिख सके। 200 विद्यार्थियो मे से एक विद्यार्थी भी एल्युमिनियम सल्फेट का सही सूत्र नहीं लिख सका हालाकि ये बहुत ही अच्छे विद्यालयो के विद्यार्थी थे।

विषय – वस्तु की अनेक अवधारणाए विद्यार्थियो की समझ मे नहीं आती हैं क्योकि इन्हे ठीक से समझाने का प्रयास ही नहीं किया जाता शिक्षको द्वारा और परिणाम होता है बच्चो की विज्ञान से दूर भागने की प्रवृत्ति जिसके कारण उनकी रुचि इस विषय मे कम हो जाती है। परिणाम होता है नकल करने की चेष्टा। केवल बच्चे ही नकल नहीं करते बल्कि उनके पालक भी अपने बच्चों को कुछ भी समझ मे न आने के कारण उन्हें नकल करने मे सहायता करते हैं। शायद आपको याद होगा कि उच्चतर माध्यमिक शिक्षा के एक परीक्षा केन्द्र पर पालको की भीड को नकल करवाने से रोकने के लिए पुलिस को गोली चलानी पडी और केवल छात्र ही नही बल्कि उनके पालक भी घायल हो गए। कहा जा रहे हैं हम लोग ? क्या हो रहा है हमारे मूल्यो को ? क्या दुर्दशा कर रहे हैं हम शिक्षा और ज्ञान की ?

विज्ञान शिक्षण कैसे करे ?

रसायन शास्त्र का विद्यार्थी होने के कारण मेरा यह अटूट विश्वास है कि रसायन विज्ञान या विज्ञान का शिक्षण प्रश्न–उत्तर विधि से बिल्कुल न किया जाए। विज्ञान शिक्षण इस प्रकार करवाया जाए कि बच्चे खो जाए इसमे और अधिक से अधिक जानने की उनकी इच्छा हो। क्यो होता है ऐसा सोचे वे। आनन्नद की अनुभूति हो उनको पढते समय। चेहरो पर चमक आ जाए उनके कुछ नया जानकर। प्राथमिक स्तर पर विज्ञान शिक्षण करते समय हमे कक्षा की चारदीवारी से बाहर आकर अपने चारो ओर के पर्यावरण–पेड, पौधे, नदी, नाले, फल, फूल, पशु–पक्षी, खदानो और उनमे प्रयोग मे आने वाली प्रौद्योगिकी, फसलो से नाता जोडना होगा। हम प्रारम्भ कर सकते हैं अपने पर्यावरण में पाए जाने वाले विभिन्न प्रकार के पौधो की पहचान उनकी पत्तियो की अलग–अलग

बनावट के आधार पर। यहीं से बच्चो द्वारा सूक्ष्म अवलोकन की शुरूआत हो सकती है। नीम और तुलसी ऐसे पौधे हैं जो प्राय. हर स्थान पर बहुतायत से मिलते हैं। इनका हमारे दैनिक जीवन मे अत्यन्त उपयोग है। सर्दी, जुकाम होने पर हम तुलसी की पत्ती दूध मे या चाय मे डालकर प्रयोग मे लाते हैं। तुलसी के 30–32 पत्ते प्रतिदिन दही के साथ खाने से अनेक रोगियो को कैन्सर जैसी असाध्य बीमारी से आराम मिला है। नीम की पत्तिया खून साफ करती हैं। नीम की पत्तियो को पानी के साथ उबालकर नहाने से त्वचा रोगो से छुटकारा मिलता है यह विधि गावो मे बहुत प्रसिद्ध है। आखे आने पर नीम की कोमल कोपलो को गाय के दूध से बने मठे के साथ पीसकर आखो मे इस्तेमाल करने पर काफी आराम मिलता है। यह भी देखा गया है कि नीम की पत्तियो को सुखाकर यदि गरम कपडो के साथ रखा जाए तो कपडो मे कीडा नहीं लगता। नीम की सूखी पत्तिया अनाज को भी अधिक समय तक सुरक्षित रखती हैं। कहने का तात्पर्य यह है कि शिक्षक प्राथमिक स्तर से ही दैनिक जीवन मे आने वाले इस प्रकार के पौधो से बच्चो का परिचय करवाए और पौधो के महत्व पर विशेष बल दे। जिससे ये बच्चे बडे होकर पेडो की रक्षा कर सके और अपने पर्यावरण मे इनके योगदान के महत्व को समझ सके।

जल की समस्या विश्व समस्या बनने जा रही है। लगता है कि अगला विश्वयुद्ध यदि हुआ तो वह जल विवाद के कारण ही होगा। शुद्ध पेय जल का मिलना अब बहुत मुश्किल हो गया है। भारतीय रेल के लगभग प्रत्येक रेलवे स्टेशन पर आपको पीने के लिए पानी की बोतले बिकती हुई मिलेगी अर्थात् यदि आपको यात्रा करनी है तो साथ में पीने के पानी की बोतल लेकर यात्रा करे। जब महानगरों, शहरो और कस्बों का यह हाल है तो हम यह कैसे अपेक्षा कर सकते हैं कि गावो मे रहने वाले लोग पीने का शुद्ध जल पी रहे हैं। उन्हें तो काफी दूर स्थित कुओ, नदी, नालो व तालाबो से पानी लाना होता है। नदी, नालो के मटमैले पानी को पीने लायक कैसे बनाया जाए यह प्रक्रिया क्यों नहीं करवाते हम लोग प्रत्येक प्राथमिक शाला मे चार घडो वाले सरल प्रयोग से। जब उपर वाले घडे की तली से बूद–बूंद टपकता पानी बजरी वाले, कोयले (लकडी के) वाले और रेत वाले घडो से गुजरेगा तो जल में उपस्थित विभिन्न प्रकार की अशुद्धिया दूर हो जाएगी। बजरी के स्थान पर कोयला और कोयले के स्थान पर रेत का घडा रखने से इस प्रक्रिया मे होने वाले परिवर्तन का अध्ययन करना भी रोचक होगा। फिटकरी को पानी मे 25–30 सैकड तक घुमाने से भी पानी के मटमैलेपन को दूर किया जा सकता है क्योकि ऐसा करने से मिट्टी के कण भारी होकर बर्तन की तह मे बैठ जायेगे। हानिकारक बैक्टीरिया को जल को उबालकर दूर किया जा सकता है। जब छोटे–छोटे बच्चे अपने नन्हे–नन्हे हाथो से इस प्रकार के छोटे–छोटे प्रयोग स्वय करेगे या अपने शिक्षको को करते हुए देखेगे तो प्रफुल्लित हो उठेगे वे बच्चे और बाल वैज्ञानिकों की नर्सरी हम तैयार कर पाएगे इस प्रकार। क्या ऐसे प्रयोगो मे बहुत पैसा लगता है या बहुत कठिन हैं ये प्रयोग ? नहीं। केवल चाहिए शिक्षक की सूझबूझ, दूरदृष्टि और अपने व्यवसाय से लगाव और छोटे बच्चो के प्रति प्यार। ऐसे छोटे–छोटे प्रयोग करने से बच्चो के मस्तिष्क मे इनकी गहरी छाप बैठ जाती है और बच्चो की रुचि बढती है विषय के प्रति, कक्षा के प्रति और विद्यालय के प्रति। चीनी कहावत मे यह ठीक ही कहा गया है कि "मैंने पढा, मैं भूल गया। मैंने देखा, मुझे याद रहा और मैंने किया तो मैं समझ गया।" उच्च प्राथमिक स्तर और माध्यमिक स्तर पर विज्ञान शिक्षण की कुछ और विद्याओ का वर्णन नीचे किया गया है –

1 पदार्थों का पृथकीकरण – उच्च प्राथमिक स्तर पर विज्ञान विषय में बच्चो को भौतिक और रासायनिक परिवर्तन, मिश्रण मे से पदार्थों के विभिन्न विधियो द्वारा पृथकीकरण एव शुद्धिकरण की विभिन्न विधिया, तत्व, मिश्रण, यौगिक, यौगिको के रासायनिक सूत्र और रासायनिक परिवर्तनो की रासायनिक समीकरण जैसे विभिन्न पाठ पढने होते हैं। पाठ्यक्रम मे इन सभी पाठो को रखने का उद्धेश्य है कि बच्चे छोटी–छोटी अभिक्रियाए एव प्रयोग स्वय करना सीखे और वैज्ञानिक विधि के अवलोकन नामक पद से न केवल परिचित हो बल्कि सूक्ष्म अवलोकन करना भी सीखे। परखनली, बीकर, स्प्रिट लैम्प, जाली, तिपाई, कीप, फिल्टर पत्र और चीनी की प्याली अर्थात् अधिक से अधिक मात्र 200 रुपये मे इन सभी वस्तुओं का प्रबन्ध कर हम बच्चो को फिल्ट्रेशन, सेडिमेन्टेशन, निथारना, उर्ध्वपातन जैसी पृथकीकरण की कुछ विधियो से परिचित करवा सकते हैं। यह सम्भव है कि सभी पाठो को क्रियाकलापों/प्रयोगो द्वारा नही पढाया जा सके किन्तु जो क्रियाकलाप आसानी से कक्षा मे शिक्षक द्वारा दिखाए जा सकते हैं वे अवश्य ही दिखलाए जाए क्योकि ऐसा करने से विज्ञान विषय में बच्चो की रुचि बढ़ेगी। उनकी जिज्ञासा बढेगी और अधिक जानने के लिए बच्चे स्वय पुस्तके पढेगे या कुछ प्रयोग स्वय ही करना चाहेगें।

2. यौगिको के सूत्र लिखना – यौगिको के रासायनिक सूत्र लिखने के लिए विभिन्न पदो का अभ्यास करवाना अत्यन्त लाभकारी होगा। विभिन्न पद इस प्रकार रहेगे –

- ☞ मूलको के सकेतो का ज्ञान
- ☞ बेसिक (क्षारीय) मूलक को पहले लिखकर उसके घनात्मक आवेश को दर्शाना
- ☞ एसिडिक (अम्लीय) मूलक को बेसिक मूलक के बाद लिखकर उसके ऋणात्मक आवेश को सकेत के उपर दर्शाना
- ☞ ऋणात्मक आवेश को क्षारीय मूलक के सकेत के नीचे दाईं ओर घनात्मक आवेश को अम्लीय मूलक के सकेत के नीचे लिखना।

इस प्रकार आप बच्चो को यौगिको के रासायनिक सूत्र लिखना सीखा सकेगे। लिखे जा सकते हैं। यह रसायनशास्त्र की भाषा है। उच्च प्राथमिक स्तर पर इस ज्ञान का अधिक से अधिक उपयोग आगे चलकर रासायनिक विज्ञान से सम्बन्धित पाठो के अध्ययन को सुगम और रुचिकर बनाने मे सहायक सिद्ध होगा क्योकि पाया गया है कि बहुत से विद्यार्थी एम.एस सी की डिग्री प्राप्त करने के बाद भी जिक फॉस्फेट, अमोनियम कार्बोनेट, एल्युमिनियम सल्फेट जैसे यौगिको के रसायन सूत्र भी ठीक से नही लिख पाते हैं। इसलिए कक्षा सात और आठ मे अधिक से अधिक यौगिको के रासायनिक सूत्र लिखने का अभ्यास करवाया जाए।

3 मोल की अवधारणा – हम सब जानते हैं कि मोल एक बहुत बडी सख्या है और इसका मान 6.023×10^{23} है। माध्यमिक स्तर पर इस अवधारणा को 6.023×10^{23} सख्या को विस्तृत रूप मे लिखकर समझाया जाए। यह पाया गया है कि अधिकतर विद्यार्थी मोल के मान को तो याद कर लेते हैं परन्तु इस महती सख्या

को समझ नहीं पाते। इसलिए यह सुझाव है कि मोल को निम्न रूप से लिखा जाए

1 मोल 6.023×10^{23} 6023000000000000000000000

इतना लिखने के बाद बच्चो को अपनी बोलचाल की भाषा मे इसे गिनने को कहे। हम पाएगे कि यह सख्या तो हमे सब गिनतियो की सीमा से भी आगे की सख्या है अर्थात् यह एक बहुत बडी सख्या है। इसका प्रयोग ऐसे अति सूक्ष्म परमाणु, अणु, आयनो या कणो को गिनने के लिए करते है जिनकी सख्या बहुत अधिक है। एक मोल चावल के दाने तो हो सकते हैं परन्तु एक मोल लडके या लडकिया नहीं हो सकती पूरे ससार मे। अब कोई भी एक सरल उदाहरण लेकर मोल के विभिन्न पहलुओ पर प्रकाश डाला जा सकता है।
उदाहरणार्थ – 1 मोल CO_2 - CO_2 के 6023000000000000000000000 अणु
अर्थात् 6.023×10^{23} अणु CO_2 के
अर्थात् C के 6.023×10^{23} परमाणु
अर्थात् O_2 के 6.023×10^{23} अणु
अर्थात् O के $2 \times 6.023 \times 10^{23}$ परमाणु
अर्थात् $3 \times 6.023 \times 10^{23}$ परमाणु

273 K एव 1 वायुमण्डलीय दाब पर 1 मोल CO_2 - 22.4 लीटर 44.0 g इतना समझाने के पश्चात् अब यह पूछा जा सकता है कि CO_2 के एक अणु की सहति कितनी होगी ? अवधारणा की पुष्टि के लिए बच्चो को अब कथनात्मक प्रश्न दिए जा सकते हैं।

4 धातुओ की क्रियाशीलता – परमाणु सरचना, आवर्त सारणी, रासायनिक बधन, मोल अवधारणा के पश्चात्, धातु और अधातु का पाठ शिक्षक द्वारा कक्षा मे कुछ क्रियाकलापो द्वारा प्रारम्भ किया जाए। सोडियम, मैग्नेशियम, एल्युमिनियम और ताबा ऐसी धातुए हैं जो आराम से हर माध्यमिक शाला मे मिल सकती हैं। इन धातुओ की जल, वायु, अम्लो से क्रिया कक्षा मे कर के दिखालाई जा सकती है। कुछ धातुए जल के साथ तीव्रता के साथ क्रिया करती हैं तो कुछ धीमे से और कुछ अत्यन्त धीमे से। उदाहरण के तौर पर सोडियम धातु इतनी क्रियाशील है कि जल के सम्पर्क मे आते ही धमाके के साथ जलने लगती है। दूसरी ओर मेग्नीशियम धातु जल के साथ धीमे–धीमे क्रिया करती है और एल्युमिनियम धातु तो जल के साथ गरम करने पर भी बहुत धीमे–धीमे क्रिया करती है। क्रिया दिखलाने के बाद इनकी क्रियाशीलता मे अन्तर खोजने का कारण पता लगाया जाए। सोचने दे बच्चो को। इलेक्ट्रॉनिक विन्यास और परमाणुओ की त्रिज्या के बारे मे कुछ सोचा जाए। सोडियम धातु के परमाणु के बाह्य कक्ष मे एक इलेक्ट्रॉन, मेग्नीशियम मे दो और एल्युमिनियम के परमाणु के बाह्य कक्ष मे तीन। सबसे नजदीकी निष्क्रिय गैस नियोन का इलेक्ट्रानिक विन्यास प्राप्त करने के लिए सोडियम के परमाणु को अपने सबसे बाह्य कक्ष से एक इलेक्ट्रॉन का विसर्जन करना होगा जबकि मेग्नीशियम धातु को दो और एल्युमिनियम धातु को तीन इलेक्ट्रॉन त्यागने होगे। इसके साथ साथ हमे यह भी मालूम है कि सोडियम परमाणु की त्रिज्या मेग्नीशियम से बडा है और मेग्नीशियम की एल्युमिनियम से। एल्युमिनियम का परमाणु सबसे छोटा होने के कारण एल्युमिनियम के नाभिकीय प्रोटोनो का एल्युमिनियम के बाह्य कक्ष में उपस्थित इलेक्ट्रॉनो के प्रति आकर्षण अत्यधिक होगा जिसके फलस्वरूप एल्युमिनियम धातु के परमाणु की इलेक्ट्रॉन त्यागने की प्रवृत्ति तीनो धातुओ मे

सबसे कम होगी और यही कारण है कि एल्युमिनियम धातु तीनो धातुओ मे सबसे कम क्रियाशील है। अब हम एक नियम निकाल सकते हैं कि आवर्त सारणी के किसी भी आवर्त मे बाए से दाई ओर जाने पर तत्वो की पानी के साथ क्रियाशीलता कम होती जाती है।

5. मॉडलो का उपयोग – कार्बनिक यौगिको का अध्ययन दसवीं कक्षा से प्रारम्भ हो जाता है। हाईड्रोकार्बन की श्रेणी मे मिथेन (CH_4) सबसे सरल यौगिक है जो कार्बन के एक परमाणु और हाइड्रोजन के चार परमाणुओ से मिलकर बना है। मिथेन के हाइड्रोजन के एक परमाणु के कार्बन द्वारा विस्थापन से नया यौगिक ईथेन बनेगा। ईथेन से प्रोपेन और प्रोपेन से ब्युटेन। यह क्रम इसी प्रकार चलता रहेगा। यहा पर बच्चों को यह-अवधारणा अच्छी तरह से बतला दी और समझा दी जाए कि हाईड्रोजन की सयोजकता 1 और कार्बन की सयोजकता 4 है। मिथेन एक बहुआयामी अणु है जिसमे हाइड्रोजन के चार परमाणु परस्पर 109^{0}-28' के कोणो पर कार्बन के परमाणु के साथ जुडे हुए हैं। चॉक के चार टुकडो को 109^{0}-28' के कोणो पर रखकर या लकडी की चार डडियो और मिट्टी या प्लास्टिसिन से दर्शाए गए चार हाइड्रोजन परमाणुओ को 109^{0}-28' के कोणों पर रखकर समझाया जा सकता है। यहा पर यह बात भी ध्यान देने योग्य है कि हाइड्रोकार्बनो के दो साथ वाले सदस्यो के बीच -CH_2 मूलक का अतर है क्योंकि – H परमाणु को हटाकर –CH_3 मूलक को लगाया गया है। ऐल्केन, ऐल्कीन और ऐल्काइन सजातीय श्रेणियो के विभिन्न सदस्यो की सरचना, समावयता और उनकी दोनो विधियो (Common & IUPAC) मे नामो के विषय मे अत्यन्त धीमे–धीमे परन्तु विस्तार से चर्चा करना कार्बनिक रसायन मे बच्चो की रुचि को बढाने मे श्रेयस्कर होगा क्योकि इसी स्तर से कार्बनिक रसायन की नीव डाली जा रही है। विभिन्न अणुओ की संरचना तथा समावयवता की अवधारणा को Ball और Stick मॉडलो की सहायता से बहुत अच्छी तरह समझाया जा सकता है।

6. विज्ञान क्लब की स्थापना – विद्यालयो मे विज्ञान क्लब की स्थापना से भी विज्ञान विषय मे बच्चो की रुचि बढ़ेगी जहा विद्यार्थियों को अपनी मर्जी से कुछ भी करने के लिए कहा जाए। शिक्षक का कार्य केवल बाल वैज्ञानिको की सहायता करना, मार्ग निर्देशन करना होना चाहिए। बाल वैज्ञानिक के अपने प्रयत्न करने के बाद, अपने प्रयोग मे असफल होने के बाद ही बाल वैज्ञानिक की सहायता करनी चाहिए क्योकि यदि सभी समस्याओ के हल तुरन्त पुस्तकों से या शिक्षक द्वारा सुझा दिए जाए तो सोचने की प्रणाली रूक जाती है। ऐसा करने से बालको की सोच मे नयापन नहीं होगा और सर्जनता कैसे होगी। यहा पर एक ग्रामीण उच्चतर माध्यमिक शाला का जिक्र करना उपयुक्त होगा। बात बहुत पहले 1974 की है, तब दसवी तक विज्ञान पढना सबके लिए अनिवार्य नही था। शाला मे लगभग 100 विद्यार्थी थे दसवी कक्षा मे और उनमे से केवल 12 विद्यार्थियों ने विज्ञान विषय लिया हुआ था वह भी अनमने मन से। लेखक ने जब उस विद्यालय मे रसायनशास्त्र के शिक्षक के रूप में कार्य करना शुरू किया तो युवा मन मे विचार आया कि इन बच्चो को खेल–खेल मे कुछ कार्योपयोगी वस्तुए बनवाई जाए। दीपावली के अवसर पर मोमबत्ती बनवाई गई। बच्चो को दे दी गई। फिर बूट

पॉलिश बनवाई गई। साबुन बनने लगा। अब बच्चो को विषय वस्तु मे भी रूचि आने लगी। युवा केन्द्र द्वारा शाला सकुल पर विज्ञान मेले का आयोजन किया गया और 12 मे से 8 बच्चो के विज्ञान के मॉडल पुरस्कृत किए गए। उस वर्ष बच्चो का विज्ञान विषय का परिणाम भी सतोषप्रद रहा। इस घटना से यह निष्कर्ष निकाला जा सकता है कि विज्ञान क्लब की स्थापना और उचित मार्ग निर्देशन द्वारा बच्चो की विज्ञान विषय मे रुचि बढाई जा सकती है।

7 अन्धविश्वास को दूर करना – प्राय सुनने मे आता है कि रात को हमे शमशान मे नही जाना चाहिए क्योकि शमशान मे रात को भूत नाचते हैं और चिन्गारिया उठती देखी जा सकती हैं। ऐसा कुछ नही है। बच्चे दसवी कक्षा मे पढते हैं कि हमारी हड्डियो मे केल्शियम फास्फेट रहता है। कुछ केल्शियम फास्फेट रेत के सम्पर्क मे आने पर उच्चताप पर फास्फोरस पेन्टा ऑक्साइड बनाता है। कुछ फास्फोरस भी बन सकता है। फास्फोरस अत्यन्त क्रियाशील होता है जिसके कारण यह वायु की ऑक्सीजन से क्रिया करके जलना शुरू कर देता है और फास्फोरस पेन्टा आक्साइड बनाता है। रात को चिन्गारिया फास्फोरस के जलने के कारण ही हैं, भूत के कारण नहीं। कुछ साधु महात्मा, फकीर बिना दियासलाई की तीली के अग्नि प्रज्वलित कर देते हैं ओर प्रभावित करके हमे ठग कर ले जाते हैं। विज्ञान मे बिना दियासलाई की तीली के अग्नि प्रज्वलित की जा सकती है। यदि आप श्वेत फास्फोरस को हवा मे खुला रख दे तो यह अपने आप जलने लग जाता है। आप एक प्रयोग कर सकते हैं बच्चो के दिमाग से यह बात निकालने के लिए कि बिना तीली के अग्नि प्रज्वलित नहीं की जा सकती। श्वेत फास्फोरस के बारीक टुकडे करके आप कार्बन डाई सल्फाइड नामक विलायक मे घोल ले एक प्याली मे। अब इसमे एक छोटा सा फिल्टर पत्र लेकर डुबो दे। इसे बाहर निकाल ले। बाहर निकालने पर जैसे ही कार्बन डाई सल्फाइड वाष्पित होकर उड जाएगा तो फिल्टर पत्र अपने आप जलना शुरू कर देगा। यह कोई चमत्कार नही है। यह तो श्वेत फास्फोरस हवा मे खुला छोडने पर जलने लगता है। यही कारण है कि फास्फोरस को पानी मे रखा जाता है। इस प्रयोग को करते समय यह ध्यान रखे कि फास्फोरस का कार्बन डाई सल्फाइड मे घोल आपके शरीर के किसी भी भाग को स्पर्श न करे नही तो शरीर में आग लग जाएगी।

निष्कर्ष · उपरोक्त सभी बिन्दुओ से हम यह निष्कर्ष निकाल सकते हैं कि हम यदि अधिक नही तो कम से कम 50 प्रतिशत समय प्राथमिक, उच्च प्राथमिक तथा माध्यमिक स्तर पर बच्चो को प्रयोग करवाने या स्वय करके दिखलाने मे अवश्य लगाए। इसके लिए अलग से प्रयोगशाला की आवश्यकता नहीं है। हम अपनी कक्षा को ही प्रयोगशाला बनाएं या कमरे की चार दीवारी से बाहर निकलकर अपने पर्यावरण को ही प्रयोगशाला का रूप दे अपने आस–पास मे उपयोग मे आने वाली प्रौद्योगिकी चाहे वह आटा पीसने वाली मशीन खेत की जमीन को बीजारोपण के लिए तैयार करने के लिए उपयोग मे लाए जाने वाले ट्रैक्टर, नलकूप की मोटर या दैनिक जीवन मे उपयोग मे आने वाले स्कूटर से सम्बन्धित हो, उसे समझने की जिज्ञासा बच्चो मे जागृत करे। बच्चो को स्वयं कुछ करने दें। कुछ हम करके दिखाए। उन्हे और अधिक प्रश्न पूछने के लिए प्रेरित करे। उनकी जिज्ञासा को कभी शात न होने दे क्योकि एक प्रश्न समस्या के समाधान के बाद दूसरे

प्रश्न/समस्या का उठना ही विज्ञान की उन्नति है। अवधारणाओ को धीमे–धीमे ओर अत्यन्त सरल और रोचक ढग से समझाने की कोशिश करे। बच्चो की पढाई को उनके दैनिक जीवन और समाज से जोडने का प्रयास करें ताकि हमारे बाल वैज्ञानिको मे एक ललक पैदा हो सके और कुछ नया करने के लिए। इस सदर्भ मे भारत सरकार के विज्ञान और प्रौद्योगिकी विभाग और ग्वालियर की बाल विज्ञान स्वयसेवी सस्था द्वारा बाल वैज्ञानिको का वार्षिक राष्ट्रीय विज्ञान मेला आयोजन निश्चित ही एक सराहनीय कदम है। आशा है कि आने वाले वर्षों मे हमारे विद्यालय अनेक प्रतिभाशाली बाल वैज्ञानिको को तैयार करने मे सक्षम होगे।

Acids, Bases and Salts
Class: VII

Dr. V. P. GUPTA

1. Overview

Children of class VII are of 11+ years of age. At this stage, children start differentiating between different types of substances they come across in their surroundings. In the chapter on 'Structure of Matter', they have learnt about symbols of elements and formulae of compounds in terms of atoms of different elements present in them. They may now be interested in knowing causes for difference in taste and properties of substances like curd, lemon, tomato, baking soda, washing soda and table salt etc. Knowledge about structure and composition of substances may help them in thinking deeper about 'inside of the molecules' leading to critical thinking about Science. The chapter on acids, bases and salts gives an opportunity to the learners to know more and more about substances found in their vicinity and find reasons for different behaviour shown by them.

As far as possible, science teachers are supposed to develop concepts through simple activities instead of merely giving information. This approach has been followed in the book entitled, "Science and Technology – A Textbook for class VII", published by NCERT. This module consists of exemplar material on development of a few concepts through activities. The chapter consists of as many as 17 major teaching points/concepts. Exemplar material on development of only a few concepts is given in the module. Rest of the concepts may be developed by teachers with the help of activities using the locally available material which will help them in their capacity building process. An effort has been made in this module to simplify the activities given in the textbook so that they can be performed easily in the class with no cost or low cost. Material required, procedural details, precautions to be observed, learning outcomes and the value(s) inculcated through activities constitute the essentials of this module.

2. Objectives

After studying and using this module teachers will be able to help their students to

(i) define acids,

(ii) classify acids as (a) mineral and organic acids, (b) strong and weak acids and (c) concentrated and dilute acids,

(iii) predict preparation of acids by dissolving the combustion product of non-metals in water;

(iv) tabulate properties of acids like (a) conducting nature (b) liberation of H_2 gas with metals (c) liberation of CO_2 with metal carbonates and bicarbonates (d) corrosive nature.

(v) define bases.

(vi) prepare alkalies by dissolving the combustion product of metals in water.

(vii) classify bases into strong and weak bases,

(viii) predict the formation of salts by the neutralisation reaction of an acid with a base.

(ix) distinguish between acids and bases with the help of indicators,

(x) list properties of salts,

(xi) list uses of acids, bases and salts and

(xii) classify salts as neutral, basic and acid salts

3. Major Teaching Points/Concepts

Content analysis of this chapter has indicated that it consists of the following major teaching points/concepts

1. Substances sour in taste and turning moist blue litmus paper red are called acids.
2. Acids generally contain hydrogen atom(s)
3. Acids can be classified into (i) mineral and organic acids. (ii) strong and weak acids and (iii) concentrated and dilute acids
4. Mineral acids can be prepared by dissolving the combustion product of non-metals
5. Acid solutions conduct electricity.
6. Acids generally react with metals to liberate H_2 gas
7. Acids react with metal carbonates and bicarbonates to literate CO_2 gas
8. Acids are corrosive in nature
9. Bases are soapy in touch and turn moist-red litmus paper blue
10. Bases can be prepared by dissolving the combustion product of metals in water
11. Bases soluble in water are called alkalies
12. Bases can be classified as strong and week bases.
13. Acid and a base combine to form a salt or salt is the neutralisation product of reaction of an acid with a base or vice-versa

14 Indicators are substances, which give different colours with acids and bases

15 Uses of acids, bases and salts

16 Properties of Salts

17 Classification of salts as neutral, basic and acidic salts

4. Exemplar Activities

Exemplar activities for development of some of the above concepts are given below.

Concept 1 Mineral acids can be prepared by dissolving combustion product of non-metals in water.

Non-metals like C, S, and P_4 form oxides like CO_2, SO_2 and P_2O_5 which on dissolving in water give acidic solutions

Material required: Long gas jars, deflagrating spoons, gas jar lids, small amount (approximately 2g) each of sulphur powder, wood chorcoal and white phosphorus, blue litmus paper and tap water.

Activity procedure: Take a small wood charcoal piece in a deflagrating (long) spoon Heat it over the flame of burner Lower the spoon into a gas jar when it starts burning After some time, cover the mouth of the gas jar with the lid The wooden charcoal piece gets extinguished. Remove the deflagrating spoon and cover the mouth of the gas jar again with the lid. Add about 10 mL of water into the gas jar to dissolve the gases Add a piece of blue litmus paper into the gaseous solution and observe. You are correct if the blue litmus paper is turned red. This is due to the formation of carbonic acid, H_2CO_3 (unstable), a weak acid obtained by dissolution of CO_2 gas (after combustion of carbon of wood charcoal) This change can be represented by the following chemical equations.

$C(s) + O_2(g) \longrightarrow CO_2(g)$ (i)

$CO_2(g) + H_2O(l) \longrightarrow H_2CO_3(l)$ (ii)
Carbonic acid

Wash the gas jar & the deflagrating spoon with water. Repeat the activity with white phosphorus and then with sulphur powder. Again observe whether blue litmus paper is turned red in these cases The acids thus

obtained are known as mineral acids as their starting material carbon, sulphur and phosphorus are found under the earths crust

Precautions

- While performing the activity with white phosphorus, it should be immediately placed in the deflagrating spoon after taking it out from bottle containing water (white phosphorus is kept in water because it catches fire at room temperature even without igniting it with a match stick)

- The deflagrating spoon should be immediately lowered down into the gas jar.

- White phosphorus is not to be heated

- While performing activity especially with sulphur powder and phosphorus, the gases should not be smelt as these are highly poisonous

Testing of Real Learning Outcomes (RLOs)

Students may be asked to write chemical equations for the products obtained by dissolving the combustion product of (a) Sulphur and (b) White phosphorus in water

Concept 2. Acid solutions conduct Electricity

Acid solutions like HCl, H_2SO_4, CH_3COOH and juices of tomato, lemon and orange are conductor of electricity

Material Required 25 mL each of dil HCl, H_2SO_4, CH_3COOH (vinegar), juice of tomatoes, lemons, orange (depending upon availability) and tamarind water, two 100 ml beakers, two graphite rods (taken out from used torch cell) or 4×10 cm copper plates, insulating wire, ammeter, torch bulb and two dry cells (1 5 volt)

Activity Procedure_ _Take about 25 mL of distilled water or rain water in a 100 mL beaker. Place two copper plates or graphite rods in the beaker Attach insulating copper wire to each rod and the battery through the ammeter and the torch bulb as shown in Fig 4.2 at page 62 of Science & Technology textbook for Class VII After connecting the battery, students

may be asked to note down reading in the ammeter and extent of glowing of bulb This activity may be repeated with 25 ml each of tap water, tomato juice, lemon juice, tamarind water, dil HCl, dil H_2SO_4 dilute acetic acid and soda water and the Table given below may be completed by the students and inferences be drawn by them

Table 2.1. Nature of water and Acid solutions

S No	Liquid/Solutions	Ammeter Reading	Glowing of bulb	Inference
1	Distilled water			
2	Rain water			
3	Tap water			
4	Dil HCl			
5	Dil H_2SO_4			
6	Dil CH_3COOH (or Vinegar)			
7	Tomato juice			
8	Lemon juice			
9	Mango juice			
10	Tamarind water			

Substance conducting electricity will glow the torch bulb and there will be movement of ammeter needle Let the students infer themselves whether acid solutions conduct electricity or not

Precautions

1. The activity should be demonstrated with acids like dil HCl, dil H_2SO_4 etc by the teacher Students may observe and note down observations

2 Activities with fruit juices, distilled water, tap water and rain water should be done by students in groups of 3-4 children

3 Each group should be given different liquids/solutions

4. Observations of different groups may be pooled

5 students may be asked to draw inferences on the basis of their observations.

Concept 3 Acids react with (i) metal carbonates and (ii) metal bicarbonates to liberate CO_2 gas.

Acids like dil HCl, dil H_2SO_4 liberate CO_2 gas on reacting with metal carbonates like Na_2CO_3, $CaCO_3$, $ZnCO_3$, $MgCO_3$ Besides HCl and H_2SO_4, the activity can be performed with lemon juice and tomato juice. Baking soda ($NaHCO_3$), washing soda (Na_2CO_3) and marble stone/lime stone are commonly available and should be widely used in such activities.

Material Required: Baking soda, washing soda, marble chip powder, lemon juice, tomato juice, dil HCl and dil H_2SO_4, a few test tubes, 100 ml beakers (3-4), Delivery tubes, lime water, candle, match stick

Activity 1.

Procedure : Take about 1 g of baking soda ($NaHCO_3$) in a porcelain dish or a watch glass. Add a few drops of lemon juice over the baking soda Brick effervescence will be evolved. Bring a burning match stick near the evolved gases The burning match stick gets extinguished Since CO_2 gas extinguishes the burning match stick, it may be inferred that the gas evolved is carbon dioxide

Repeat the activity by replacing baking soda by washing soda and adding a few drops of tomato juice vinegar or dil HCl or dil H_2SO_4. In each case the liberated gas will extinguish the burning match stick

Activity 2.

Procedure · Take about 5 g of washing soda or lime stone powder in a test tube fitted with a delivery tube as shown in Fig 4.3 at page 65 in the NCERT textbook of Science and Technology for class VII Remove the delivery tube and add about 10 mL of dil HCl Fit the delivery tube again Take about 5 mL of lime water (supernetant liquid obtained after adding water to quick lime and left overnight) in another test tube Dip the delivery tube into lime water. The gas liberated as a result of reaction of washing soda with dil HCl

turns lime water milky This is the characteristic reaction of CO_2 gas (If we exhale in lime water for some time it turns milky It is due to CO_2 gas which we exhale) The activity may be repeated by replacing washing soda or lime stone powder by antacid tablets, which contain weak bases like sodium hydrogencorbonate ($NaHCO_3$), $Mg(OH)_2$ and $Al(OH)_3$

Precautions

1 Dilute solutions of HCl and H_2SO_4 should be used

2 Heating may be necessary in case of lime stone powder

Testing of RLOs

1 Complete and balance the following equations

$NaHCO_3 + H_2SO_4 \longrightarrow NaHSO_4 + CO_2 +$

$Na_2CO_3 + HCl \longrightarrow + CO_2 +$

$CaCO_3 + HCl \longrightarrow CaCl_2 + +$

2 How do the out acid tablets help us in getting relief from acidity?

Concept 4. Bases can be prepared by dissolving the combustion products of metals in water

Metals like Na, Mg, Al etc. on burning form oxides which on dissolving in water form bases

Material Required

Small amount of Na and Mg metals, fusion tubes, test tubes, pair of tongs, beakers, blue and red litmus papers.

Activity Procedure

Take a small piece of Na metal (of the size of pea or still smaller) in a fusion tube and heat over a spirit lamp or a Bunsen burner. Sodium metal melts within seconds and takes the shape of mercury globule. Heat the fusion tube till red-hot Pour the hot fusion tube in a beaker containing about 10-15 mL of water Filter the Solution Divide the solution in two parts Dip a blue litmus paper in the first part and red litmus paper in the second part Ask students to note down the change in their notebook

Repeat the activity by holding a small magnesium ribbon with the help of pair of tongs and heat till you get a white ash. Dissolve this ash in about 10-15 mL of water Again test with blue and red litmus paper Ask students to note down change in colour.

In both these cases, you will not find any colour change with blue litmus paper This indicates that the aqueous solutions are not acidic (concept 1) In both the cases you will find that red litmus paper is turned blue. This is the test for bases Hence, it can be inferred that the aqueous solutions obtained by dissolving the combustion products of metals like Na, Mg etc are basic or alkaline in nature This is due to the formation of hydroxides **Metal hydroxides soluble in water (NaOH, $Mg(OH)_2$ etc. are called alkalies.**

Testing of RLOs

1 Write balanced Chemical equations for the combustion of (i) Na, (ii) Mg, (iii) Ca (iv) K, (v) Cu (vi)Al.

2 Write names and formulas of the hydroxides obtained by dissolving the above combustion products in water.

3 Out of the above hydroxides, which are alkalies?

4 Write formulas of oxides of the following and classify them into (i) acidic oxides and (ii) basic oxides.
Mg, C, S, Na, Ca, P, Cu and Al

Concept 5. Salt and water are formed as products by the neutralisation reactions of acids and bases

An acid on reacting with a base forms salt and water This reaction can be represented by the following chemical equations:

Acid + Base $\longrightarrow$ salt + water

This can be illustrated by the following examples

Examples:

$HCl + NaOH \longrightarrow NaCl + H_2O$ (i)

$2HCl + Mg(OH)_2 \longrightarrow MgCl_2 + 2H_2O$ (ii)

$3H_2SO_4 + 2Al(OH)_3 \longrightarrow Al_2(SO_4)_3 + 3H_2O$ (iii)

$HNO_3 + NH_4OH \longrightarrow NH_4NO_3 + H_2O$ (iv)

$CH_3COOH^* + NaOH \longrightarrow CH_3COONa + H_2O$ (v)

$HCOOH^* + NaOH \longrightarrow HCCOONa + H_2O$ (vi)

In all these reactions, H atom of the formic acid (H atom marked with' in acetic acid and formic acid) is replaced by metal ion or ammonium group obtained from the base. Depending upon strength of the acid and a base, different types of salts are obtained. The salt formation reaction of an acid with a base or vice versa is called neutralisation since the nature of acid or a base is neutralized. But all salts are not neutral. We get a neutral salt when a strong acid reacts with a strong base, otherwise we may get acidic or a basic salt as given in Table 5.1.

(i)	**A strong acid and a strong base form a neutral salt.**
(ii)	**Strong acid and a weak base form acidic salt.**
(iii)	**Weak acid and a strong base form basic salt**

Formation of different types of salts is exemplified in the following Table. Fill in the blanks may be completed by the students to assess their learning.

Table 5.1. Types of Salts

Acid	Nature	Base	Nature	Salt	Type
HCl	Strong	NaOH	Strong	NaCl	Neutral
HCl		KOH	Strong		Neutral
HCl		$Ba(OH)_2$	Strong		
H_2SO_4	Strong	NaOH		$BaSO_4$	
HNO_3	Strong	KOH			
H_2SO_4		$Ba(OH)_2$			
HCl		NH_4OH	weak		
HCl		$Cu(OH)_2$	weak		
HNO_3		$Al(OH)_3$	weak		
HNO_3		$Ba(OH)_2$			
H_2CO_3	weak	NaOH			Basic
H_2CO_3		KOH			
H_2CO_3		$Mg(OH)_2$	weak		
H_2SO_4		NH_4OH			
H_2SO_4		$Cu(OH)_2$	weak		
HCOOH	weak	NaOH			
CH_3COOH	weak	NaOH			
CH_3COOH		KOH			

Application of Neutralisation Reactions

The above exercise may help students in understanding nature of salts obtained by neutralisation reactions of acids and bases. This phenomenon of neutralisation is very useful in our daily life Excess formation of HCl in our body develops acidity which is neutralized by taking antacid tablets which contain weak bases like $Mg(OH)_2$, $Al(OH)_3$ and $NaHCO_3$ Formic acid injected in our body by ant or scorpion sting is neutralized by rubbing the concerned part of the body with baking soda ($NaHCO_3$) or quick lime (CaO) Acid burns caused by spilling of acid on our body can be controlled either by washing with excess of cold water or by spreading a layer of baking soda In this way, applications of neutralisation reactions may be highlighted

Values Development

Three important values of keen and minute observation, drawing inferences and understanding our environment can be developed by going through this module very carefully and performing the above suggested activities

References

1. NCERT, 2003, Science and Technology – A Textbook for class VII pp 58-81

2 NCERT, 2003, Teaching Science and Technology – Self-Learning Material for Teachers (Upper Primary Stage)

3 V P Gupta, 1989, in some Exemplars on Activity Lessons, Regional College of Education (NCERT), Bhopal, pp 29-33

4 V. P Gupta, 2003, Acids and their Properties (Part - I) Lesson Plan in Science (Chemistry). Regional Institute of Education (NCERT), Ajmer, pp 1-7.

SEPARATION OF SUBSTANCES

CLASS VI

Dr. R. K. Parashar

OVERVIEW

We are surrounded with variety of materials such as air, water, soil, rocks, milk, vegetables, fruits and metals like iron, copper, aluminum etc some substances found in nature are used as such, but some are used only after separation For example, we peel off the fruits before eating them. Tea is filtered before drinking. Pebbles and hay is picked out from food grains There are many reasons for separation depending upon our needs

OBJECTIVES

After going through this module you would be able to help the students to

- distinguish between pure substances and mixtures,
- highlight importance of separation of substances,
- use the process of separation in their day to day life processes and
- select the proper method of separation based upon the nature of constituents of the mixture

MAJOR TEACHING POINTS/CONCEPTS

This module discusses the following concepts

- A pure substance consists of particles of only one kind and has a fixed melting or boiling point
- Mixtures (impure substances) have particles of two or more kinds, hence mixtures can not have fixed melting or boiling points
- Grains are heavier than husk
- If one of the component of mixture is present in a small quantity and has a distinct shape and size, it is selectively separated by manual selection
- The smaller particles of mixture pass through the holes of a sieve and bigger particles remain on the sieve
- A magnet attracts magnetic substances from the mixture of non-magnetic substance
- Some substances on heating directly convert into gaseous state The gaseous state of the substance is cooled to get pure solid.

- Heavier insoluble solid particles present in a liquid settle down quickly
- The suspended light clay particles in water become heavy on treatment with alum and hence settle down at the bottom.
- If mixture of insoluble solid in liquid is passed through proper pore size filter paper, the insoluble solid is retained on the filter paper.
- When fine suspended particles containing liquid is rotated in closed container, the heavier material moves towards the bottom of the container and the lighter material remain on the top.
- When mixture of non-volatile and volatile substance is heated, the volatile fraction (of lower boiling point) gets evaporated out
- On cooling hot saturated solution, crystals of the pure solid are obtained
- Two immiscible liquids form two distinct layer when filled in a separating funnel.

TRANSACTIONAL STRATEGIES OF CONCEPTS

Students recognize various materials found in their surroundings. The need of separation should be elaborated on the student's prior experiences and observations. Separation is done for

1 removal of undesirable material from desirable material
2 removal of impure substance from pure substance and
3. to improve the quality of the substance.

For teaching this unit, you can use a variety of charts; Activities suggested can either be demonstrated by the teacher and then performed by the students The following concepts have been discussed in this unit

PURE SUBSTANCES AND MIXTURES

Concept 1. A pure substance consists of particles of only one kind and has a fixed melting or boiling point.

Material Required

Sulphur powder, water, convex lens, capillary tube, thermometer, Test-Tube, watch glass, and melting point apparatus.

Activity

Students may be asked to observe sulphur powder with the help of convex lenses Melting point of pure sulphur is 115^{0} C If it is impure them it will melt at a temperature lower than 115^{0}C

Boiling point of pure water is 100°C If it is impure, it will boil at a temperature higher than it

Note The above activities will be demonstrated by the teacher in the class

Concept 2: Mixture (impure substances) have particles of two or more kind , hence mitures can not have fixed melting and boiling points.

Material required

Soil sample, impure sulphur, tap water, capillary tube, Test-tube, watch glass, convex lens, thermometer, melting point apparatus

Activity

Observe the soil under convex lens soil has particles of more than one kind

The melting point of impure sulphur is less than 115°C The boiling point of tap water is more than 100°C and not fixed depending upon the quantity of various salts present in it

RLOs

Classify following into pure substances and mixtures Sherbat, Iron, Rock salt, Soft drink, Milk, Gold, Tap water wheat from field, distilled water

B. PRINCIPLE AND TECHNIQUE OF SEPARATION

It involves the application of characteristic properties of various constituents of mixture

SEPARATION OF SOLIDS FROM SOLIDS

Winnowing

Concept 3: It is based on the fact that grains are heavier than husk

Activity

This is the method used by the farmers to separate grains from husk The husk is released from a height The husk forms a heap at distance away from the heap of wheat grains

Hand picking

Concept 4: If one of the component of mixture is present in a small quantity and has a distinct shape and size it is selectively separated by manual selection.

Activity

Hard picking is usually done to separate undesirable substances such as small pieces of pebbles and other material from wheat, rice and pulses.

Sieving

Concept 5: The smaller particles of mixture pass through the holes of a sieve and bigger particles remain on the sieve.

Activity

The sieves of different hole sizes are used at homes to separate husk from wheat flour similarly, fine sand is also separated from gravels during Construction of a house.

Magnetic Separation

Concept 6: A magnet attracts magnetic substances from the mixture of non- magnetic substances.

Material required

Iron filings, sand, tray, bar magnet

Activity

In the laboratory, the iron filings are separated from sand by using bar Magnet In factories scrap iron is separated from the heap of waste material by using strong electromagnets fixed to a crane.

Sublimation

Concept 7: Some substances on heating directly convert into the gaseous state. The gaseous state (vapors) of the substances is cooled to get pure solid.

Material required

Common salt, ammonium chloride, china dish, sand bath, funnel, cotton wool , watch glass, spatula

Activity

The mixture of common salt (NaCl) and ammonium chloride (NH_4Cl) is taken in china dish and is kept on a sand bath A funnel is inverted over the mixture The top of stem of funnel is plugged with cotton Cotton piece soaked in cold water is spread over the funnel to help in fast condensation of vapors The mixture is heated ammonium chloride being volatile, sublimes The vapors rise up and condense on the cooler part of the funnel When heating is stopped, the condensate (pure NH_4Cl) is removed from the funnel and collected The non-volatile common salt is left in china dish

Examples of some solids, which sublime on heating, are camphor, Iodine and naphthalene

RLOs Name the method for separation for separation of

(i) husk from corn
(ii) iodine from salt
(iii) tea leaves from iron filings
(iv) pebbles from rice
(v) pravels from fine sand
(vi) iron filing from sulphur powder

SEPARATION OF INSOLUBLE SOLIDS FROM LIQUIDS

Sedimentation and decantation

Concept 8: Heavier insoluble solid particles present in a liquid settle down quickly.

Activity

Take a mixture of sand and water in a beaker Sand settles down at the bottom with clear water above it in the beaker Pour carefully the supernatant water into another beaker without disturbing the sediment. In this way, the supernatant liquid over the sediment can be separated by decantation.

Loading

Concept 9: The suspended light clay particles in water become heavy on treatment with alum and hence settle down at the bottom.

Activity

The fine clay particles settle down in beaker very slowly If an alum Piece is stirred 3-4 times in the muddy water. The alum particles settle sown on the clay particle as a result of which clay particles become heavy and settle down easily The clear water can be separated by decantation

Filtration

Concept 10:If mixture of insoluble solid in liquid is passed through proper pore size filter paper, the insoluble solid is retained on filter paper.

Activity

Fold round sheet of filter paper two limes, take three parts on one side to give it shape of a cone Place the filter paper cone in a funnel wetted with water, place the filter paper cone in a funnel. Fit the funnel in funnel stand and place a beaker below it Take the muddy water in a beaker Pour muddy water carefully over a glass rod into a funnel and collect the water passing through the filter cone in a beaker

Centrifugation

Concept 11: When fine suspended particles containing liquid is rotated in closed container, the heavier material moves towards the bottom of the container and lighter material remain on the top.

Activity

Rotate the test tube containing clay particles suspended in water The clay particles being heavier, settle at the bottom The process of centrifugation is widely used for domestic and commercial purpose to separate, lighter cream/butter from milk/curd

RLOs: Fill in the blanks

(i) Cream is separated from milk by ----------

(ii) A mixture of chalk powder and water is separated by ----------

(iii) ----------is a process for separating the suspended clay particles by alum treatment

(iv) Tea leaves can be separated from the liquid by the process of----------

SEPARATION OF SOLUBLE SOLIDS FROM LIQUIDS

Evaporation

Concept 12:When mixture of non volatile and volatile substance is heated, the volatile fraction (of lower boiling point) gets evaporated out.

Activity

Separation of common salt dissolved in water-Take solution in a china dish The china dish is kept on sand both starts The solution is heated by spirit lamp On heating, liquid of solution stands evaporating and after some time, the non-volatile salt is left in the china dish as a residue The china dish is allowed to cool and then the salt is collected Making use of this method of evaporation, table salt is commercially prepared from seawater

Crystallization

Concept 13:On cooling hot saturated solution, crystals of the pure solid are obtained.

Activity

Take 50 ml of water in a china dish and add some alum powder in it Continue adding alum powder till it keeps dissolving to get a saturated solution. Fitter to remove the impurities if any Heat the china dish over a water both slowly to prepare a super saturated solution. Add one crystal of alum as a seed and allow the china dish to cool, crystals of pure alum are formed.

RLOs: (i) How is common salt is obtained from seawater
(ii) How will you prepare a big crystal of pure sugar from impure powder sugar

SEPARATION OF TWO IMMISCIBLE LIQUIDS:

By separating funnel

Concept 14:Two immiscible liquids form two distinct layer when filled in a separating funnel.

Activity

Fill the kerosene and water mixture in separating funnel and allow it to stand for some time. The heavier liquid (Water) settle at the lower part of the separating funnel, whereas lighter liquid (kerosene) forms the upper layer. Remove the stopper of the separating funnel The stopcock of the separating funnel is opened and the heavier liquid (water) is collected in a clean beaker. The lighter liquid (kerosene) remains in the separating funnel.

SEPARATION USING A COMBINATION OF VARIOUS METHODS

Separation of components of a mixture of iron filings, sand and common salt

Activity

The method is based on the principle that iron is attracted by magnet Common salt is soluble in water while sand is insoluble in water. Take the mixture in a plate. A powerful magnet is moved through the mixture Iron filings are attracted by the magnet and are removed. Now salt and sand are left in the mixture It is poured in to a beaker containing water Salt is dissolved and sand remains undissolved On filtration sand is collected over the filter paper, while salt solution is collected as a filtrate The salt solution is evaporated in a china dish to recover the salt

RLOs: 1. How will you separate a mixture of mustard oil and water?

2 How will you separate a mixture of camphor, common salt and Iron filings without using water

Coal and Petroleum
Class: IX

Dr. V. P. Gupta

1. Overview

Coal and petroleum are two natural resources of energy. Both of these are found under the earth's crust formed by very very slow decomposition of plants and animals due to high temperature and pressure. Inside the earth, the process might have taken millions and millions of years. Both coal and petroleum contain a large number of hydrocarbons (compounds of carbon and hydrogen atoms **only**). Besides carbon and hydrogen elements, both coal and petroleum also contain nitrogen, oxygen and sulphur. Hydrocarbons undergo combustion easily in the presence of oxygen of air to produce large amount of heat energy and light Hence, coal and petroleum are two sources of energy LPG (liquefied petroleum gas), petrol, diesel, kerosene oil, hard and soft coke, CNG (compressed natural gas), dry cleaning reagents, boot polish, pitch (material used for carpeting of roads), a large variety of plastic, products, dyes, drugs and various cosmetic items are obtained directly or indirectly from coal and petroleum. Besides the gold deposits, bumper crops and industrial production, economy of any Nation also depends upon the deposits of coal and petroleum. Hence, these days, coal and petroleum are termed as the black gold It will be highly desirable for the teachers to highlight importance of these two materials in our daily life. If possible, this unit may be started by arranging field visits to the nearby coalmines petroleum wells, petroleum refineries or petrochemical industrial or by arranging film shows in the class to appreciate the role of technology in making our livelihood more comfortable

Many of the concepts of this unit like preparation of coal gas, ethane, ethene can be understood by the students by demonstrating their preparation in the classroom or the laboratory by the teachers. Some of the properties of hydrocarbons can also be demonstrated Emphasis may be given on conservation of energy and new thinking may be generated among the learners for converting smoky fuels like wood, coal, cattle dung found in their surroundings into smokeless biogas or gobargas as an alternative source of energy.

From this unit, children start learning A, B, C of organic Chemistry (Chemistry of carbon compounds) It will be worthwhile at this stage to take up the concepts of tetravalency of carbon, nomenclature and isomerism of alkanes, alkenes and alkynes in detail so as to develop a strong foundation at this stage for learning of organic Chemistry in higher classes the present module consists of development of a few concepts with the help of activities followed by questions to test the real learning outcomes.

2. Major Teaching Points/Concepts

Content analysis of this chapter has revealed that the following major teaching points/concepts are to be learnt.

1 Coal and Petroleum as Natural Resources of Energy
2. Composition of different types of coal
3. Destructive Distillation of coal
4 Composition of Petroleum
5. Refining of Petroleum
6. Difference between Natural Gas and Petroleum Gas
7 Technological Applictions of combustion of Hydrocarbons
8 Harmful Effects of combustion
9 Tetravalency of carbon and catenation
10 Nomenclature and Isomerism in Hydrocarbons
11 Preparation of methane Gas
12 Biogas
13 Preparation of Ethene Gas
14 Addition Reactions of Ethene
15 Hydrogenation of vegetable oils
16 Preparation of Ethyne Gas and
17 Addition Reactions of Ethyne

3. OBJECTIVES

The exemplar material on development of some of the concepts as given in the module my help you in achieving some of the objectives of this unit. But it is expected from the teachers that they will help their students to achieve all the objectives of the chapter on 'coal and petroleum' as given below.

(i) To realise the importance of coal and Petroleum as the natural resources of energy and use them judiciously;

(ii) To acquaint them with composition of different types of coal and Petroleum,
(iii) To list products obtained by the destructive distillation of coal,
(iv) To describe refining process of petroleum by using modern technology and make a list of petrochemicals obtained by fractional distillation of petroleum alongwith their applications in daily life,
(v) To distinguish between natural gas and petroleum gas,
(vi) To understand and describe technological applications of combustion of hydrocarbons,
(vii) To make them aware of harmful effects of combustion of hydrocarbons and motivate them to bring awareness in society to check air pollution;
(viii) To explain the concept of tetravalency of carbon and give reasons for a very large number of carbon compounds,
(ix) To classify open chain hydrocarbons into alkanes, alkenes and alkynes based upon their structures,
(x) To write structures and common and IUPAC names of isomers of alkanes, alkenes and alkynes,
(xi) To prepare methane, ethene and ethyne gas in the laboratory and distinguish between them,
(xii) To develop an alternative pollution free source of energy by converting cattle dung into biogas and
(xiii) To handle and assemble the glass apparatus for preparation of gases like methane, ethene and ethyne

3. Transactional Strategies for Development of Concepts

Transactional Strategies for development of a few concepts of this chapter are given below·

Concept 1. Destructive Distillation of coal

Destructive distillation of coal (heating of coal in the absence of air) can be understood by performing the following activity in the class.

Material Required

Bituminous coal (10g), Hard glass test tube, Delivery tubes, iron stands, blue and red litmus papers, dropper

Procedure

Take 10g of bituminous coal in a hard glass test tube fitted with a delivery tube in a test tube containing 10 ml of tap water The test tube is also fitted with a delivery tube for exit of the gases Set up the apparatus as shown in Fig 19 1 (p 212 of NCERT textbook of Science and Technology for class IX) Heat the hard glass test tube strongly for 10 minutes On heating, the volatile matter present in coal is given out Black coloured oily liquid settles down in the test tube containing water. Soluble gases dissolve in water and the water immiscible gases come out of the delivery tube Following activities may be performed in the class with the help of students:

(i) Bring a burning matchstick near the gases coming out of the delivery tube. Gases start burning. Thus it can be inferred that these gases can be used as a fuel Gases are a mixture of CO, CH_4 and H_2. This mixture is known as coal gas and used as a fuel

(ii) Dismantle the apparatus Add a few drops of aqueous solution of the test tube with the help of a dropper first on a blue litmus paper and then on a red litmus paper You will find no change in blue litmus paper but the red litmus paper turns blue indicating that the aqueous solution is alkaline in nature Smell the aqueous solution Does it resemble with the smell in the toilets? This is due to dissolution of ammoma gas obtained by the destructive distillation of coal indicating that N is also present in coal

(iii) Decant the aqueous layer and observe colour, smell and physical state of the substance left in the bottom of the test tube This black coloured, viscous, obnoxious smelling substance is called coal tar It is a very rich source of carbon compounds used for the manufacture of large number of substances like dyes, drugs, plastics, explosives, pesticides etc. Due to its importance, it is known as black gold

(iv) Observe the state of the substance left in the hard glass test tube and compare it with the original coal Do you find any difference? After removal of the volatile matter, the left out black solid is called coke Carbon is the major constituent of coke

Testing of RLOs

- How do you conceive the formation of coal under the earth's crust?

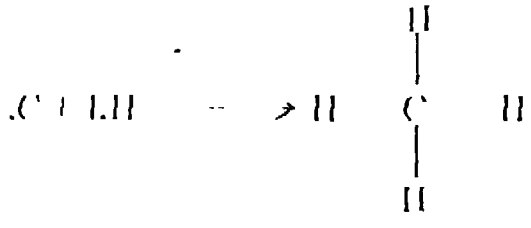
- In the above activity, why do we heat coal in a closed hard glass test tube?
- Hard glass test was kept tilted towards right, why not towards left?
- Can you think of a project of converting coal into a non-polluting source of energy? Please try
- Represent the above process by a flow sheet diagram

Concept 2. Tetravalency of Carbon and Catenation

The concepts of tetravalency of carbon and its catenation property may be developed by following the discussion given below

Atomic number of carbon being 6, carbon atom has six electrons with 2 electrons in the first shell (K) and 4 electrons in the 2nd shell (L). To attain the nearest inert gas configuration for stability, the carbon atom may either lose 4 electrons or gain 4 electrons, which is very difficult from energetic considerations. Here, reference may be made to the chapter 5 of chemical bonding. Students may suggest themselves the other alternative of sharing of electrons to form the covalent bonds. Since there are 4 electrons in the outermost shell, carbon may form covalent bonds by sharing its four electrons with the four electrons of other atoms - may be carbon or other than carbon. Sharing of two electrons between two atoms gives rise to a single covalent bond, of two electrons between two atoms forms a double covalent bond and of six electrons between two atoms gives rise to a triple covalent bond. Moreover, carbon atom can share its electrons with other atoms of carbon element or atoms of other elements viz., hydrogen, oxygen, sulphur, nitrogen etc. Since four electrons of carbon are to be shared with carbon or other atoms to attain the nearest inert gas configuration of organ, the carbon atom is said to be tetravalent

Methane is the simplest compound of carbon obtained by sharing its four electrons with four electrons of four hydrogen atoms



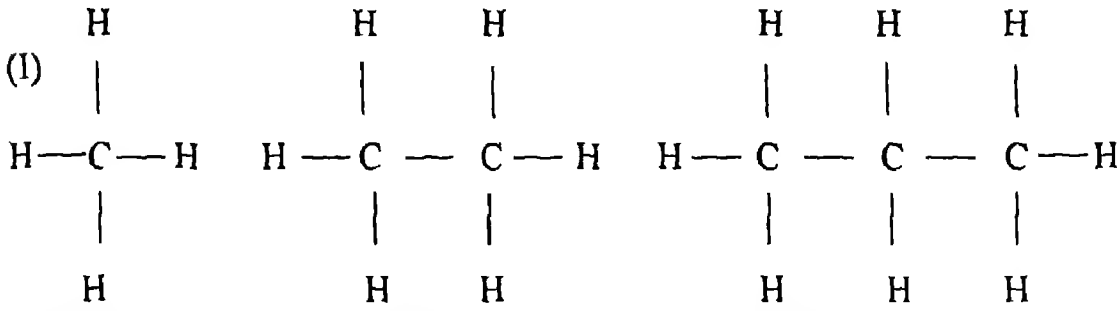
Tetrahedral shape of methane molecule may be highlighted here It was found by Le Bell and Vant Hoff that the four valences of carbon atom are directed towards the four corners of a regular tetrahedron and the each H bond angle was found to be $109^0 - 28'$ as shown below·

Tetrahedral shape of Methane

The multiplaner tetrahedral shape of methane may be explained to the students either by the ball and stick model or even by four chalk pieces depending upon the resourcefulness of the teacher

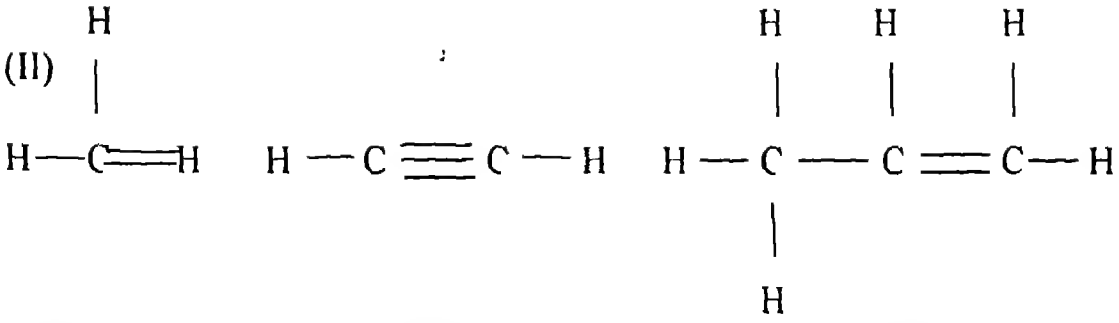
Since there are numerous ways of Combination, carbon atom is said to possess the unique property of forming chains of different types with carbon or other atoms This property of carbon is called catenation. (forming chains). Students at this stage may be asked to write different ways and means of completing carbon octet like the structures shown below

(I)



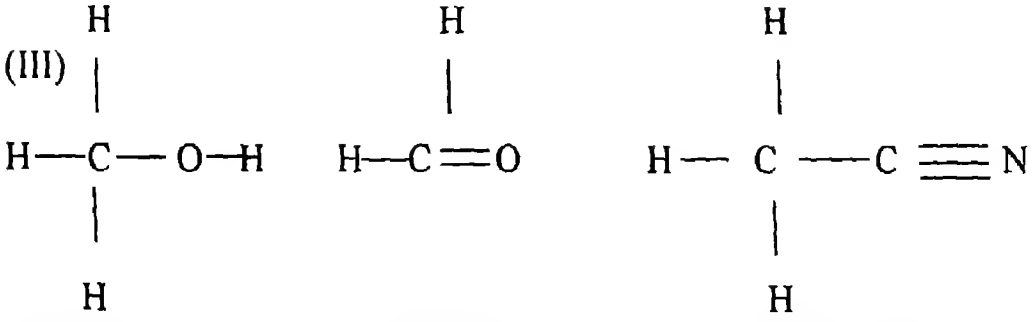
Methane Ethane Propane

(II)



Ethene Ethyne Propene

(III)



Methanol Methanal Ethanenitrile

Testing of RLOs

1. Why the four valencies of carbon atom are not directed at 90^0 instead of $109^0 - 28'$?
2. write different structures of compounds corresponding to the molecular formula $C_4H_{10}O$ keeping in mind that carbon is tetravalent, hydrogen is monovalent and oxygen atom is bivalent.
3. why is the property of cate nation shown by carbon element to the greatest extent, by silicon to some extent but not by germanium at all though all these elements belong to the same group?

Concept 3. Definition and classification of Hydrocarbons

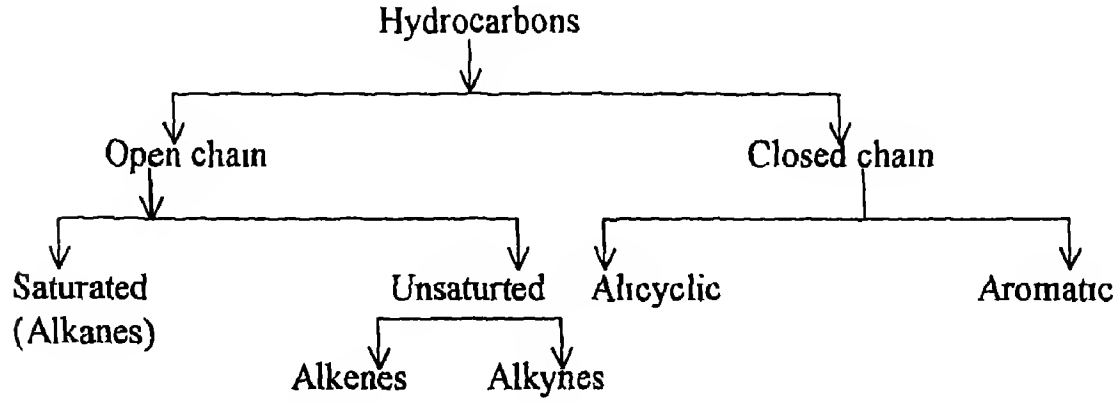
3.1 Definition of Hydrocarbons

Hydrocarbons are the compounds which contain atoms of hydrogen and carbon elements **only** Due emphasis may be laid on the word **'only'**

because a large number of carbon compounds contain hydrogen and carbon atoms but they are not hydrocarbons For example, alcohols, ethers, aldehydes, ketones, carboxylic acids, carbohydrates contain C and H atoms but they are not hydrocarbons Most of the books as well as teachers do not take note of this important information as a result of which students start committing this mistake from the very beginning in defining hydrocarbons

3.2 Classification of Hydrocarbons

Following flow sheet diagram may be useful for understanding classification



Closed chain compounds are to be studied in higher classes Open chain hydrocarbons can now be understood in terms of their structures and nomenclature of alkanes, alkenes and alkynes, as discussed in the next concept.

Concept 4. Nomenclature and Isomerism in Hydrocarbons

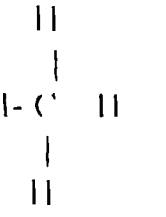
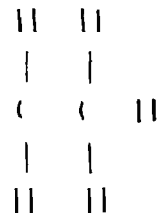
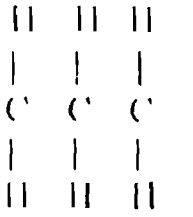
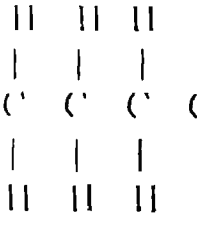
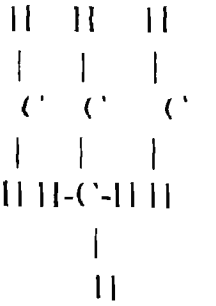
Nomenclature and Isomerism are the fundamentals of Chemistry of carbon compounds For understanding nomenclature and isomerism in hydrocarbons, intensive practice of writing of structures and naming of different homologous series of alkanes, alkenes and alkynes is to be done by the students after discussions by the teachers in the class. The following strategies may be useful in understanding the basics of hydrocarbons

4.1 Alkanes

Alkanes are saturated hydrocarbons They contain single covalent bonds between C and C and C – H. They are represented by the general formula, C_nH_{2n+2} where n represents number of carbon atoms and 2n+2 represents number of hydrogen atoms. While writing their names in IUPAC system, suffix-ane is added to the name representing number of carbon

atoms present in the longest continuous chain in alkane. The trivial names are also used in IUPAC system upto butane. Prefixes like n (normal), iso etc. used in common system are not used in IUPAC system. Teachers may asks students to develop Table of the type given below

Table 1 Nomenclature of Alkanes

No. of C atoms	Molecular Formula	Structural Formula	Common Name	IUPAC Name
1	CH_4		Marsh gas/Methane	Methane
2	C_2H_6		Ethane	Ethane
3	C_3H_8		Propane	Propane
4	C_4H_{10} (a)		n-Butane	Butane
	(b)		isobutane	2-Methylpropane

5. C_5H_{12} (a) $CH_3-CH_2-CH_2-CH_2-CH_3$ n-Pentane Pentane

(b) $CH_3-CH(CH_3)-CH_2-CH_3$ isopentane 2-Methylpropane

(c) $CH_3-C(CH_3)_2-CH_3$ neopentane 2,2-dimethylpropane

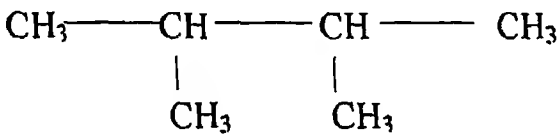
It may be emphasized at this stage that there is only one way of representing alkanes upto propane, but when we reach butane (C_4H_{10}), the four carbon atoms can be represented in two ways (a) by writing four carbon atoms continuously or (b) by writing three carbon atoms in a continuous chain and attaching the fourth carbon atom to the second carbon atom Carbon being tetravalent, the fourth valency of carbon is to be satisfied by attaching the requisite number of hydrogen atoms as shown in structures (a) and (b) for C_4H_{10} in Table 1. Hence, the molecular formula C_4H_{10} represents two compounds or two structures (a) & (b) i.e Butane and 2-Methylpropane These two structures (a) and (b) for molecular C_4H_{10} amd three structures (a), (b) and (c) for C_5H_{12} possess the same molecular formula but differ in their properties due to difference in their structures **Such compounds possessing same molecular formula but different properties are known as isomers (iso-similar). Since difference in properties is due to difference in their structures, these isomers are known as structural isomers.** Moreover, difference in structures of a, b for C_4H_{10} and a, b and c for C_5H_{12} is due to difference in nature of chain of carbon atoms Structure a corresponding to C_4H_{10} and C_5H_{12} possess (a) continuous chain of carbon atoms but structures (b) and (c) have side chains also Hence, structural isomers a, b and c are also known as chain isomers It may, however, be remembered that continuous chain of carbon atoms can be written as in different ways as shown below

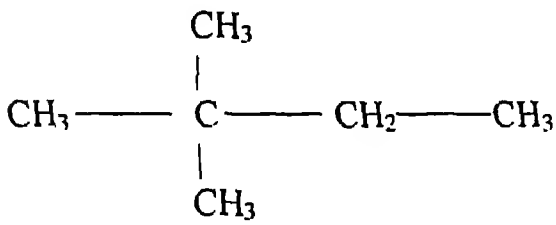
$CH_3-CH_2-CH_2-CH_2-CH_3$ or $CH_3-CH_2-CH(CH_2-CH_3)$ or $CH_3-CH(CH_3)-CH_2-CH_3$

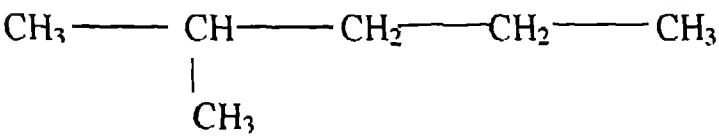
All these structural representations correspond to one and only one compound i.e pentane Most of the students are found treating as chain isomers This point needs emphasis while writing structures of alkanes This may further be supplemented by asking students to write structures of different isomers corresponding to the molecular formula C_6H_{14} This exercise will give students ample of chance to arrange six carbon atoms in different ways If possible, the ball and stick models of different isomers of hexane may be used by the students to represent different isomers corresponding to the molecular formula C_6H_{14}

While writing IUPAC name of alkanes, this point may be stressed that the compound is to be named as derivative of the corresponding alkane containing the longest continuous chain of C atoms Numbering is to be done from that end of the chain which gives the lowest number to the substituent as illustrated by the following exercise:

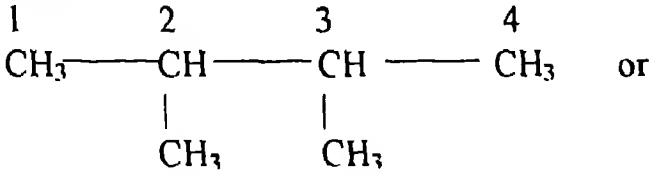
Write IUPAC names of the following compounds.

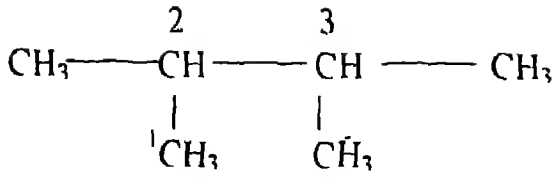
1 

2 

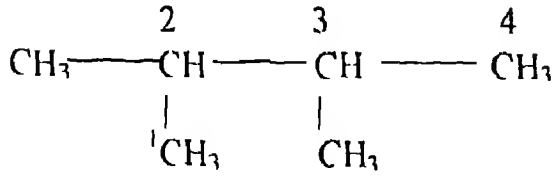
3 

Solution 1. In this compound, the longest continuous chain is that of four carbon atoms



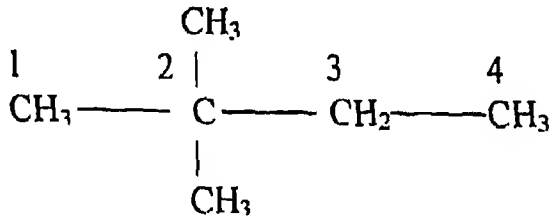


or

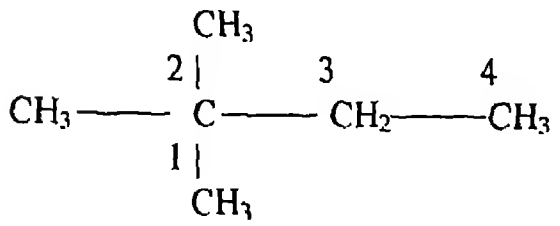


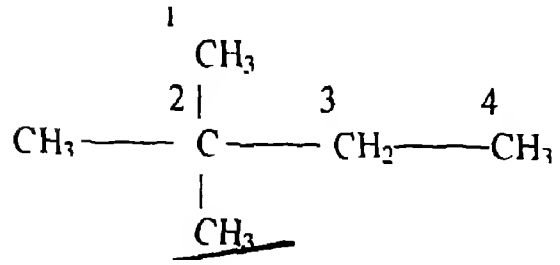
Hence, this compound is derivative of butane. But in this compound, one H atom from carbon 2 and one H atom from carbon 3 have been replaced by two methyl groups Thus name of this compound will be 2,3 – Dimethylbutane

Solution 2. In this compound also, the longest continuous chain is that of four carbon atoms



or





This compound is also derivative of butane Here, we find that two hydrogen atoms of carbon 2 have been replaced by two methyl groups Thus name of this compound will be 2,2 –Dimethylbutane

Solution 3 Compound 3 has got the longest chain of five carbon atoms meaning thereby that this compound is the derivative of pentane in which one H atom from carbon 2 has been replaced by methyl group Hence, name of this compound is 2-Methylpentane

4.2 Alkenes

Alkenes are those class of open chain hydrocarbons, which contain one double bond between two carbon atoms Alkenes are represented by the general formula CnH_2n where n is the number of carbon atoms. Since there is to be a double bond, hence the first member of alkene series is ethene with molecular formula as C_2H_4 Naming in common system is done by replacing 'ane' of alkane by 'ylene'. In IUPAC system, the compound is named by replacing 'ane' of alkane by 'ene' Structures and nomenclature of a few members of alkene series are given in Table 2 Students may be asked to write structures themselves

Table 2. Structures and Nomenclature of Alkenes

No of carbons	Molecular formula	Structural formula	Common Name	IUPAC Name
2	C_2H_4	$H_2C= CH_2$	Ethylene	Ethene
3	C_3H_4	$CH_3—CH=CH_2$	Proplyene	Propene
4	C_4H_8 (a)	$CH_2=CH—CH_2—CH_3$	Butylene	1-Butene
	(b)	$CH_3—CH=CH—CH_3$	Butylene	2-Butene
	(c)	$CH_2=C—CH_3$	isobutylene	2-Methylpropene

Molecular formula C_4H_8 corresponds to three structural isomers (a), (b) and (c) .Structures (a) and (b) possess same molecular formula differ in the position of double bond Thus compounds (a) and (b) are said to be position isomers. Compounds (a) and (c) differ in the nature of chain of carbon atoms Compound (a) has a continuous chain of four carbon atoms but compound 'c' has a chain of three carbon atoms with one side chain Compounds (a) and (c) are the examples of chain isomers Similarly

compound 'b' and 'c' are the examples of chain isomers but they als in the position of the double bond They are also the examples of p isomers Understanding of nomenclature and isomerism in alken further be strengthened by asking students to write structures and names of different isomers corresponding to the molecular formula C_5

4.3 Alkynes

Alkynes are another class of unsaturated open chain hydro which contain one triple bond. Alkynes are represented by the formula C_nH_{2n-2} where n is the number of carbon atoms As the trip (the bond obtained by sharing of 3 electrons from each carbon atom be between two carbon atoms, first member of the series must cont carbon atoms. First member of the series is commonly known as ac Hence compounds are popularly known as acetylenes The suffix ' alkane is replaced by the suffix 'yne' for naming these compo IUPAC system. Structures and nomenclature of a few members of series are given in Table 3.

Table 3. Structural and Nomenclature of Alkynes

No of Carbons	Molecular formula	Structural formula	Common Name	IUPA Nam
2	C_2H_2	H--C≡C—H	Acetylene	Ethy
3	C_3H_4	CH_3--C≡C—H	Methylacetylene	Prop
4	C_4H_6 (a)	1 2 3 4 CH_3--C≡C--CH_3	Dimethylacetylene	2-But
		(b) 1 2 3 4 H--C≡C—CH_2—CH_3	Ethylacetylene	1-But

Structures (a) and (b) corresponding to the molecular formu differ in the position of the triple bond Hence, these structures (a) are position isomers

1 Why alkanes are also known as paraffins?

2 What is the molecular formula of third member of alkene series Also write structures of different isomers corresponding to th molecular formula

3 What is the difference between alkenes and alkynes? Can yo think of any method of converting C_3H_4 into C_3H_8?

4 Write structures of different isomers corresponding to th molecular formula of 4th member of alkyne series

5 Indicate primary, secondary and tertiary carbon atoms in 2 Methylpentane

Concept 5. Preparation of Methane Gas and its properties

Methane Gas is formed in marshy places by stagnation of plan Hence, it is also known as marsh gas Coalmines are very rich source methane gas. Methane gas can be prepared in the laboratory by heatin sodium methano ate with soda lime Soda lime is a mixture of sodiu hydroxide and calcium oxide (quick lime) mixed in the ratio of 3 1 Sin during heating, one molecule of CO_2 is lost from sodium methanoate, th reaction is also called decarboxylation This can be represented by t following chemical Equation

$CH_3COONa + NaOH + CaO \rightarrow CH_4 \uparrow + Na_2CO_3$

Sodium ethanoate — 3 — 1

(Soda lime)

Materials required

CH_3COONa (1g), Soda lime (3g NaOH and 1 g CaO), Hard gla test tubes (2), delivery tube bent at angles of 120^0 and 90^0 at the two en water trough Beehive shelf, Gas jars (2), Spirit lamp or a gas burner, bl and red litmus papers, bromine water

Procedure

Preparation of methane gas can be demonstrated in the class by heating a mixture of sodium ethanoate and soda lime in a hard glass tube fitted with a delivery tube, the other end of which passes through water into the beehive shelf Take 4 g of sodium ethanoate and 4 g of soda lime (3 g of NaOH & 1 g of Cao) in a hard glass test tube and set up the apparatus as shown in Fig 19 4 (p 217, NCERT Textbook of Science and Technology for class IX) Heat the mixture and allow a few bubbles of methane gas mixed with air to escape After about 1 minute, take a gas jar or a hard glass test tube Fill it with water upto the brim and invert it over the beehive shelf. Methane gas being insoluble in water is collected by downward displacement of water Collect 2-3 gas jars. Put lids over the gas jars and keep them on the table. Perform the following activities:

1. Ask students to observe colour and smell of the gas. They are correct if they report that methane gas is a colourless and an odourless gas.

2 Bring a lighted match stick near the upper surface of the gas jar. Methane gas starts burning Heat and light energy are obtained by burning of methane gas. Hence, methane gas can be used as a fuel.

$$CH_4 + 2O_2 \xrightarrow{\Delta} CO_2 + 2H_2 + \text{Heat}$$

3. Bring moist blue and red litmus papers near the gas and observe the colour change, if any

4 Add one ml of bromine water to another gas jar Does the orange red colour of bromine disappear?

Stagnated wet cattle dung alongwith plants waste on slow degradation gives rise to methane gas alongwith N_2, H_2 and CO_2 gases This mixture of gases are collectively known as biogas. This property of conversion of cattle dung into biogas is being made use of in checking environmental pollution by using the cattle dung, the plant wastes as the alternative source of energy especially in the rural areas of our country This point may be highlighted in the class. If possible, students may be taken to see functioning of the biogas plant in the nearby area This will help the students to relate science with technology which has a direct bearing with their society.

Testing of RLOs

1 Making use of the chemical reaction for the preparation of methane gas, suggest the reagent for the preparation of ethane gas. Also write chemical equation for the same.

2 What is the role of CaO while preparing methane gas by heating sodium ethanoate with a mixture of CaO and NaOH?

Concept 6 Preparation of Alkenes and their properties

Alkenes are unsaturated hydrocarbons. They can be prepared by heating kerosene oil in the absence of air. Kerosene oil is a mixture of alkanes containing 12 to 15 carbon atoms. Kerosene oil on heating in the absence of air gives rise to **lower alkanes along with alkenes**. If heating is done in the absence of a catalyst, it is known as thermal cracking. On the other hand, if heating is done in the presence of a catalyst, it is known as catalytic cracking. Kerosene oil on heating in the presence of pumice stone may give rise to ethene alongwith other alkenes. Ethene is popularly known as ethylene. It is used in the manufacture of polyethylene or polythene the packaging material and the plastic containers.

Materials Required

Kerosene oil (10 ml), sand, Hard glass test tubes, beehive shelf, water trough, spirit lamp or a gas burner, blue and red litmus papers, Delivery tube bent at angles of 120^0 and 90^0 at the two ends, bromine water, aqueous $KMnO_4$ Solution and aqueous KOH solution.

Procedure

Take about 10 g of dry sand and soak in about 10 ml of kerosene oil. Take this kerosene soaked sand in the hard glass test tube. Fix the hard glass test tube tilted towards right in a stand and place a few pieces of broken china dish. Fit the delivery tube bent at 120^0 into the hard glass test tube. Introduce other end of the delivery tube bent at 90^0 into beehive shelf through the water trough. Heat the pumice stone (broken china dish pieces)

till red hot and then heat sand soaked in kerosene oil Fill 2-3 gas jars or hard glass test tubes with water Place jar lid over its mouth and invert one of the gas jar on the beehive shelf after allowing a few bubbles to escape Like alkanes, alkenes are also immiscible with water. Ethene alongwith higher alkenes and alkanes can be collected by downward displacement of water. Collect at least three gas jars or test tubes

Cover mouth of the gas jars with the help of jar lids and keep them on the Table Perform the following tests with the help of students.

(i) Ask students to observe colour and smell of the gases

(ii) Test the gases with moist blue and red litmus papers

(iii) Add a few drops of bromine water in one of the gas jars You will find that the reddish orange colour of bromine water is discharged.

(iv) Add a few drops of aqueous $KMNO_4$ and aqueous KOH to another gas jar Pink colour of $KMnO_4$ is discharged.

(v) Bring a lighted match stick near the upper surface of the gas jar and observe what happens.

Testing of RLOs

1 Write the chemical equation of thermal cracking of n – hexane

2 Suggest the possible chemical equations for thermal cracking of $C_{12}H_{26}$ (dodecane) present in kerosene oil. Name different alkanes and alkenes thus obtained.

3 Do the tests (iii) and (iv) suggest the presence of hydrocarbons different from alkanes? If yes, why? If not, why?

4 Write the addition reactions of (i) C_2H_4 and (ii) propene with (a) Br_2 water (b) Alkaline $KMnO_4$ solution (c) H_2 in the presence of Ni

Concept 7. Preparation of Ethyne Gas and its properties

Ethyne also belongs to the class of unsaturated hydrocarbons. Ethyne is popularly known as acetylene. It is used in the form of oxyacetylene flame for welding purposes and artificial ripening of fruits. Ethyne contains one triple bond. Since the triple bond has to be between two carbon atoms, ethyne (C_2H_2) is the first member of the series. Ethyne can be prepared by reaction of water with calcium carbide.

$$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$$

Ethyne

Material required

Calcium carbide (10 g), 250 ml volumetric flask, thistle funnel, Delivery tube bent at 90^0, 120^0 and 120^0, water trough, beehive shelf, Hard glass test tubes or gas jars, blue and red litmus papers, bromine water, $KMnO_4$ solution and KOH solution.

Procedure

Place 10 g of calcium carbide in 250 ml volumetric flask fitted with a thistle funnel and a delivery tube the other end of which passes through water trough into the beehive shelf. Set up the apparatus as shown in Fig 19.7 (p 219, NCERT Textbook of Science and Technology for class IX). Add a few drops of water. Allow the initial bubbles to escape as they contain air present in the delivery tube. Place an inverted hard glass test tube filled with water over the beehive shelf. Collect 4 – 5 test tubes of the gas thus obtained by downward displacement of water. Perform the following tests.

(i) Ask students to observe colour and odour of the gas.

(ii) Bring a burning match stick near the mouth of test tube ad see whether this gas burns in air.

(iii) Test with moist blue and red litmus papers and ask students to observe change in colour if any.

(iv) Add a few drops of bromine water (carefully) to one of the gas jars and ask students to observe change in colour.

(v) Add a few drops of alkaline $KMnO_4$ solution (aqueous $KMnO_4$ + aqueous KOH) to another gas jar and ask students to infer

Testing of RLOs

1 Make 3-4 packets of 10 g of calcium carbide and put these packets along with unripe bananas or mangoes for one day, 2 days and 3 days. What change do you find in the state of unripe fruits after each day? Write a brief description of your daily observations

2. Write m.f and structures of different isomers corresponding to the 4^{th} member of alkyne series.

3 Can tests iii) and (iv) mentioned above be used to distinguish between saturated and unsaturated hydrocarbons.

4 How will you convert C_3H_4 into C_3H_8?

5. How many C – C and C – H bonds are present in (a) C_3H_8, (b) C_3H_6 and (c) C_3H_4?

6. Write the balanced chemical equations for reactions of (i) C_2H_2 and (ii) 2 – Buyne with (a) H_2 and (b) Br_2 water.

Value Development

Five important values of (i) keen and minute observations (ii) logical thinking (iii) drawing inference (iv) keeping patience and (v) conservation of our environment can be developed by going through this module very carefully and performing the suggested activities mentioned therein

References

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Development of Values at Secondary Level through Science Experiments

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1. Science and Technology

Science is a systematic study and knowledge of natural and physical phenomena. National Curriculum Framework (NCF 2000) for school education describes science as the creative response to the curiosity and capacity to wonder. The National Policy on Education (1986) clearly emphasized the need of learning of science as a part of general education without compartmentalising into its different disciplines i.e. why during the last sixteen years science has been taught at the upper primary and secondary stage as a single discipline. In the light of NCF, it is now being felt that technology (Science of mechanical and industrial arts) is increasingly influencing our quality of life. Hence, a need was felt to include the component of technology in the science course at the upper primary and secondary stage to emphasise upon the applications of various principles of science to technology in our day-to-day life in view of the strong organic linkages between the two.

Learning of science increases the spirit of enquiry, creativity and objectivity along with aesthetic sensibility. It aims to develop well-defined abilities of knowing, doing and being. It also nurtures the abilities to explore and seek solution to the problems related to environment and daily life situations and to question the existing beliefs, prejudices and practices in society. Science concerns itself with the fundamental knowledge of universe, world and its environment.

2. Scientific Process

Science operates through its processes. Hence, science teaching is to be different from that of the other subjects. Mere question answer method will not be enough. Thinking based upon keen and minute observations with the help of activities/experiments is to be generated amongst the learner. Teaching learning of science needs to be characterised by focused emphasis on processes of science which may consist of the following steps:

- Careful observations
- Sensing of problems
- Making hypotheses (On the basis of observations)
- Literature survey/consulting teachers or and friends
- Identification of a particular problem
- Experimentation for seeking solution.
- Data collection and analysis
- Interpretation of data
- Drawing inferences
- Modification of hypotheses (in the light of experimental results)
- Limitations and scope for further studies.

In our classroom teaching, we will have to perform activities for removal of misconceptions, if any, develop and strengthen the concepts on the basis of seeing, doing and thinking This will lead to development of one very important value i e. truth besides the other related values of critical thinking and reasoning as shown in fig 1.

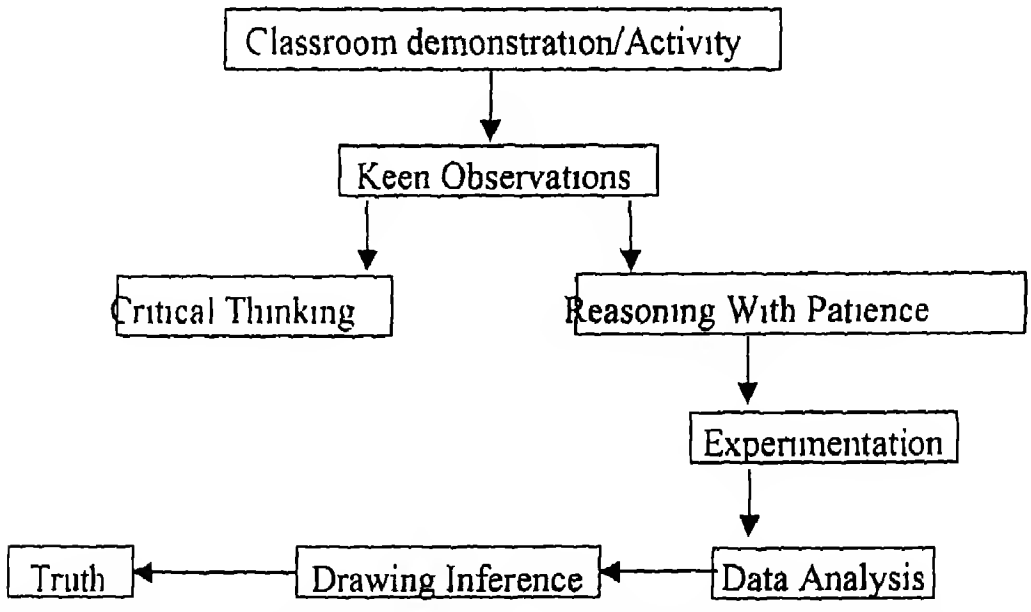


Fig. 1: Development of Values Through Science and Technology

3. Values

The word, value is derived from the Latin word, 'Valere' meaning to be strong and vigorous According to the Collins dictionary (1964), values means 'worth', 'importance', 'utility' To be of value is to have certain virtues. Different Indian Schools of thought have defined values differently Charvaka school defines values as happiness and happiness is value. In Jain Philosophy, value is celibacy and control of senses The yoga darshana treats the realizations of the eight fold of means of value, Ashtang marg of Patanjali A widely accepted definition considers value to be conceptions of the desirable influencing selective behaviour A value is a belief upon which a man acts by preference

Values are attributes that confer on man humanism and peace Values are concepts that conserve, comfort, promote and protect life They shape the moral personality of an individual Values enhance the finer side of one's potential A value is a real relationship between a person and an environmental situation which evokes an appreciative response in the individual. Kireet Joshi (1981) mentions that the education that promotes among youth the values of self-control, discipline and right habit of thought and conduct is necessary True education is a man making education Values foster peace, order, dignity, beauty, grace and delight. Values in one word are the divine side of a man Real education should become an instrument of social change and national development. It should move towards humanism, liberalism and universalism Rajput (2000) expects a teacher to be a good human being besides being a good researcher or a good teacher.

Any human activity, thought or idea, feeling, sentiment or emotion which could promote self-development of the individual in all its dimension could be said to constitute a value Value should also confine to the welfare of the larger social units such as the family, the community, nation and ultimately the whole world of which the individual is a member Value education is not simply a matter of choosing a set of values from among competing values and then transmitting them to the students but internalising those values in one's personal life

The National Policy of Education (1986) lays emphasis on value education The NPE clearly reflects the governments desire to make readjustments in the curriculum in order to make education a forceful tool

for the cultivation of social and moral values National Curriculum Framework for school education brought out by NCERT (2000) mentions that school education in the country seems to have developed some kind of neutrality towards the basic values. The curriculum further emphasises that a comprehensive programme of value inculcation must start at the very earliest stage of school education as a regular part of schools daily routine. The entire educational process has to be such that the boys and girls of this country are able to know 'good', to love 'good' and to do 'good', and grow into mutually tolerant citizens.

Many National and Regional seminars on value education have been held since the declaration of National Policy of Education (1986) and many more are taking place to find ways and means for inculcation of values amongst children. As many as 83 values have been identified by NCERT and in the recently concluded National Seminar on Value Education Through Vocational Courses by PSSCIVE, NCERT (2000), more than 100 values have been identified.

4. Science Experiments and Values

Two training programmes for KRPs of SIE/SCERT and DIETs of J&K and Uttranchal States were conducted by the authors for implementation of NCF in their respective state. The participants were taken to the Chemistry laboratories of the Institute/DIET for conducting a few simple Science activities/experiments to discuss whether some values can really be developed by performing some experiments. The following six experiments were conducted.

1. Cleaning of muddy water.
2. Separation of two immiscible liquids.
3. How to make pond water fit for drinking?
4. Separation of two compounds insoluble in water (sand and naphthalene)
5. To prove that air contains $1/5^{th}$ of oxygen.
6. Determination of pH of various solutions

Participants of both the groups were of the view that a large number of values can be developed among learners through various science experiments, provided they are conducted scientifically The values, which the groups feel can be inculcafed through science experiments, are as under

1 Keen and minute observations

2 Systematic procedure

3 Analytical thinking

4 Open mindedness

5 Patience

6 Mutual co-operation

7 Scientific attitude

8 Sense of belongingness

9 Social concern

10. Self-confidence etc

Details of a few simple experiments alongwith list of various values developed through each of them are given below·

4.1 Cleaning of Muddy Water

Mental Processing: Thinking of a solution

Principle involved: Aluminium cations present in the potash alum fasten the process of coagulation as a result of which heavy suspended particles settle down at the bottom of the container.

Procedure

1. Treatment of muddy water with a small amount of alum to load the smaller insoluble particles and allow them to settle down at the bottom of the container.

2. Decantation

3 Separation of impurity to get pure water

Values Developed

1 Societal concern

2 Sense of belongingness

3 Patience

4 Development of a procedure

5 Development of reasoning and critical thinking.

6 Importance of pure water

7. Problem solving ability

4.2: Separation of Two Immiscible Liquids

Mental Processing: The liquids provided were clear Each of them left some mark on the walls of the container, one of them having an offensive odour

Principle involved: This experiment is based on the principle of difference of specific gravity. Liquid with low specific gravity remains in the upper layer while the one with higher specific gravity remains in the lower layer.

Solution procedure: we named two liquids as A and B and took 20 ml of each liquid with the help of a measuring cylinder in a beaker. Two layers were formed. Then this solution of two immiscible liquids was transferred to a separating funnel kept on our seat Shook the two liquids vigorously for same time and then allowing the separating funnel to remain undisturbed for some time on a tripod stand till two distinct immiscible layers appeared Opened the pinchcock of funnel and transferred the lower layer in one beaker and upper layer in the other beaker Thus two layers of immiscible liquids were separated

Problem faced: In the beginning when the stopper of the separating funnel was not removed, liquids did not pass even on opening the pinchcock
Values developed: After completion of this simple activity we feel that the following values can be inculcated

1 Handling of the glass apparatus and successful separation of the two liquid develops self-confidence

2 Initiation for performing other scientific experiments

3 Understanding of the environment and applying application of this principle in daily life

4 Development of reasoning and logical thinking

5 Development of scientific temper

6 Patience ultimately leading to truth

7 Seeking solution of problems

4.3: Making Pond Water Fit for Drinking

Mental Processing: Given water contained many suspended matter It had some colour also. The given solution and the materials kept at our seat-four earthen pots, small pebbles and wood charcoal indicated for the technique,to go for removal of impurities by using the earthen pots and the material provided

Procedure: The earthen pots were arranged in such a manner that the empty one was kept at the base followed by one containing sand and then containing charcoal and at the top of it was placed the pot containing small pebbles The pond water was poured in the earthen pot kept at the top. Within five minutes the pitcher kept at the bottom received clean water free from suspended particles which was transparent enough After boiling, this water can be used for drinking

Educational Implications/Inculcation of Values

- It develops the observation skill and insight of a person
- It proves that whole is always important than parts.
- We had a whole situation and on its overall observation we succeeded in reaching a logical conclusion.
- Such type of an activity develops handling of apparatus, reasoning, scientific attitude and creativity

4.4: Separation of Two Compounds Insoluble in Water

Mental Processing: Thinking, reasoning and getting solution

Principle: Some substances change directly from solid to the vapour state on heating This phenomenon is called sublimation

Procedure: The mixture of two compounds was taken and its physical properties were observed Each compound was found insoluble in water but one compound was having unique smell The smell resembled that of naphthalene balls We were told that one of the compounds converts into gaseous state directly on heating. The mixture was taken on a watch glass placed on a sand bath. One inverted funnel was placed over it, plugged with cotton Cotton was moistened with cold water and whole of the funnel was covered with it On heating, naphthalene changed into vapours directly and condensed into a solid substance on the inner surface of the funnel wherefrom it was collected easily Sand was left as such on the watch glass. In this way, the two compounds got separated

Values developed

1 Patience
2. Thinking
3 Reasoning
4. Systematic Approach
5. Critical Thinking
6 Confidence
7 Pleasure
8. Mutual Co-operation.

4.5: To Prove that Air Contains 1/5th of Oxygen

Mental processing: Air is a mixture of gases. Containing Nitrogen, Oxygen besides Carbon Dioxide and other gases Oxygen is a supporter of combustion and changes into CO_2 as a result of combustion which dissolves in water. Therefore, oxygen not available after combustion would create vacuum which will be filled by water resulting in increase in water level

Principle involved

Oxygen in necessary for combustion and carbon dioxide is soluble in water

Procedure: Inverted the empty measuring cylinder over an un-burnt candle placed in a dish containing water. We recorded the level (x) of water over the measuring cylinder This gives the effective volume of air in the cylinder

Now burnt the candle and inverted the cylinder over the burning candle which extinguished after sometime Water level rose inside the cylinder and recorded as (y) The difference (y - x) is the volume of oxygen The activity was repeated and readings were recorded by using two different cylinders

Result: It was fond that ratio of oxygen to the total volume of air is 1.5

Values Developed

1. Keen observations
2. Reasoning
3 Problem solving
4 Self-confidence
5 Decision making
6 Mutual cooperation
7 Scientific temper
8 Learning by doing
9. Inquisition

4.6: Determination of pH of various fruit juices/solutions

Principle: pH of solutions (lemon juice, tomato juice, tamarind juice, orange juice, aerated drinks, washing soda solution and baking soda solution) can be determined with the help of pH paper A substance is said to be acidic if its pH lies below 7 to 1 and alkaline if pH lies above 7 upto 14 The pH bears a spectrum of colors corresponding to different pH values

Mental Processing/Procedure

The pH of solution can be determined by dipping the pH paper in the solution and matching the colour thus obtained with the standard colours indicated on the pH paper When the fruit juices of commonly available fruits like lemon, orange, tomato and tamrind, aerated cold drinks, baking powder and washing soda solutions were used for determination of their pH, the results as given in Table 1 were obtained by the participants

TABLE – 1: pH and Colour Change With the pH Paper of Different Solutions

S. N.	Fruit juice/solution	Colour change	PH
1	Lemon	Orange	4
2	Tomato	Orange	4
3	Tamrind	Redish orange	3
4	Aerated cold drink	Reddish orange	2-3
5	Baking soda	Dark green	9
6	Washing soda	Dark blue	11

The values which can be developed as a result of this activity as reported by the participants are given below:

1) Keen observation
2) Confidence
3) Reasoning
4) Mutual cooperation
5) Sciencetific temper
6) Truth

5. Conclusion

The teachers and the practitioners for inculcation of values through science teaching can think of such type of classroom activities and problems in Science and Technology However, it may be remembered that it is not an overnigh exercise Values are learnt or inculcated by a long and continuous process Values can be inculcated only when we practise them, follow them in schools/colleges and society Students consider teachers as their models Therefore, before taking up the task of value inculcation amongst our students, we teachers, teacher educators and administrators will have to present ourselves as models for our students and get rid of us from the clutches of politics and selfish motives It is thus hoped that we will be successful in changing destiny of our country by producing good citizens with good values

LIGHT

Prof. H. C. Jain

Overview

Students are quite familiar with the words like light, shadows, mirrors, lenses, microscope, telescope etc However how the light behaves, when it falls on any object, mirror or lens, is taken for granted Activity based method showing the rays and its path when they fall or pass through any object/material can be quite effective in teaching – learning process while dealing the topic on light This can be followed by ray diagrams illustrating incident, reflected, refracted, emergent rays etc Also the use of mirrors and lenses can further be explained without any difficulty if the basic concepts about image formation are clear to the students The following text takes into consideration all such aspects by identifying the various concepts and the activities to be used to illustrate the same

Objectives After going through this module you will be able to help the learners to

- recognize that objects are seen due to scattering of light
- classify the materials as transparent, translucent and opaque objects
- generalize that light travels in a straight line.
- discriminate between parallel, convergent and divergent beams of light
- reason out that shadows are formed due to rectilinear propagation of light
- recognize the umbra and penumbra regions of light
- explain lunar and solar eclipses
- explain the working of pin hole camera
- infer the laws of reflection
- explain the formation of images in case of plane, concave and convex mirrors
- interpret the laws of refraction of light and dispersion of white light
- explain the formation of images in case of concave and convex lenses.
- describe the construction and working of microscope and telescope
- discriminate between myopia and hypermetropia.

Concept: Objects are seen due to scattering of light

Activity: Take some objects e.g wood, book, mirror etc Place them in dark Are these visible? Now put them in light. Ask the students why are they visible? Discuss that the light, which falls on these objects, is scattered in all directions. This light on entering the eye makes these objects visible Also discuss that there are some objects, which are visible in the dark as well These are known as luminous objects e g. dial of a watch painted with radium. Objects not visible in the dark are known as non-luminous objects.

Concept: Objects can be classified as transparent, translucent and opaque.

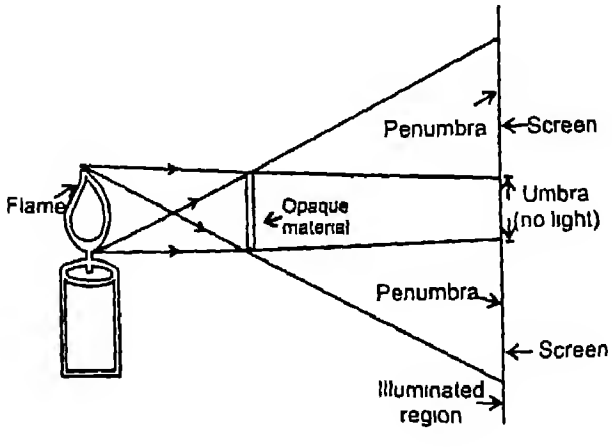
Activity: A number of objects glass, iron, plastic, wood, an oil or greased paper can be taken Put all of them in light and ask the students to see through them Depending upon whether the light passes through, light passing in a diffused manner and light not passing at all, classify them as transparent, translucent and opaque respectively

Concept: Light travels in a straight line.

Activity: Take three cardboards Make a hole in each of them at the same height Set them in a straight line in front of a lighted candle See through the cardboards By altering the position of the cardboards, infer that light travels in a straight line

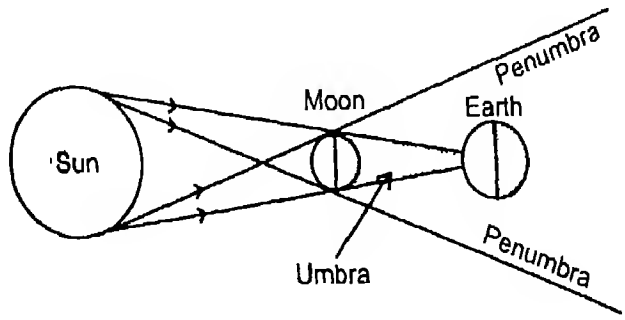
Concept: Shadows are formed due to rectilinear propagation of light.

Activity: Place a cardboard in front of a lighted candle as shown in figure Also hold a white sheet of paper on the other side of the cardboard. Ask the students to observe the white sheet Classify the three regions (i) region having darkness/shadow/no light as umbra (ii) region having uniform illumination as bright and (iii) region having varying intensity and not being completely dark as penumbra



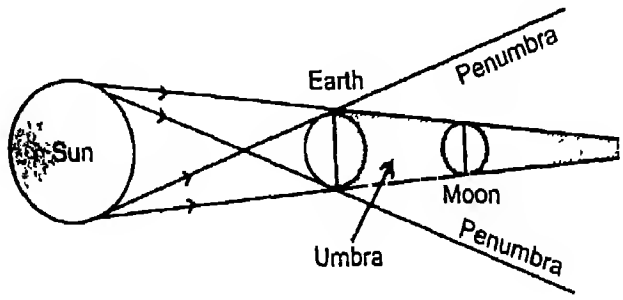
Concept: Lunar and solar eclipses are the manifestation of shadows.

Activity: Take three balls in order of decreasing size Treat the ball having the biggest size as sun, having the medium size as earth and smallest as moon Place them as given below



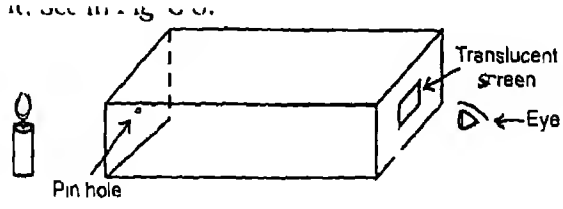
Move the smallest one (moon) towards the medium sized ball (earth) and look at the former one. As the smallest one comes closer to the medium size ball, it will be seen that the biggest ball (sun) is not visible Infer that the moon being so closer to earth casts its shadow on earth and the sun is not visible from earth This is solar eclipse

Suspend a circular cardboard on a wall Take a ball as earth. Throw light on it using a torch so that earth's shadow is formed on the wall Move the torch and earth ball such that earth's shadow covers moon Ask the students to observe cardboard It will be seen that is darkened when it is in earth's shadow Discuss that lunar eclipse occurs when sun, earth and moon are in one straight line



Concept: Working of Pinhole camera is based on rectilinear propagation of light.

Activity: Take a shoebox Make a pinhole on its one side Cut a rectangular slit on the opposite face and cover it by a translucent paper Put a lighted candle in front of the pinhole and look at the opposite face Ask the students what do they observe? Discuss with the help of the following figure



Some activities using ray streak apparatus
(Reflection of light)

Concept: Any two beams of light which are equidistant throughout their path are called parallel beams.

Material required - A Black sheet of paper having holes at equal Distance, Ray streak apparatus

Activity: Keep either of the above two in front of sunlight. What do you observe? Expected answer – parallel beam of light coming out from holes/streaks

(for getting longer beams of light apparatus should be put on an inclined plane in the above and the following activities).

Concept: Irregular reflection is the reflection at the rough surface

Material required - Ray streak apparatus, Book (rough surface).

Activity: Allow a parallel beam of light coming out of ray streak apparatus to fall on a book placed in its path. What do you observe?

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Expected answer Book is illuminated but beams are not visible after striking on the book

Discussion: The surface of the book is rough So whenever parallel beam of light falls on any rough surface then they move in different directions and parallel beams are not visible Such type of reflection is called irregular reflection

Concept: Regular reflection takes place from smooth and polished surfaces.

Material required: Ray streak apparatus and plane mirror

Activity: Close all the slits except one of the ray streak apparatus. Place a plane mirror in front of it What do you observe? Now place a plane mirror in front of parallel beam coming out of ray streak apparatus What do you observe?

Expected answer: After striking on the mirror the parallel beams move in a particular direction and remain parallel

Discussion: As the plane mirror is smooth and polished, the mirror reflects all the beams in a regular direction Such type of reflection is called regular reflection

Concept: When parallel rays fall on plane mirror, concave mirror and convex mirror, the reflected rays are parallel, converging and diverging respectively.

Material required: Plane mirror, concave mirror, convex mirror, ray streak apparatus

Activity: Place a plane mirror in front of ray streak apparatus What do you observe?

Expected answer. We observe that the parallel beams of light after striking on the mirror are reflected as parallel beams or the distance between the beams after reflection remains the same.

Discussion. When a parallel beam of light falls on a plane mirror, after reflection again the beams are parallel

Activity: Place a concave mirror in front of parallel rays coming from ray streak apparatus What do you observe?

Expected observations When the parallel rays fall on the concave mirror, after reflection, the reflected rays meet at a point

Discussion: When parallel beam of light falls on a concave mirror it converges all the reflected rays to a point Such mirrors are also called converging mirrors and such beams of light are called converging beams.

Activity: Place a convex mirror in front of parallel rays from ray streak apparatus What do you observe?

Expected answer the reflected rays appear to diverge from a fixed point behind the mirror

Discussion Which surface of mirror is reflecting the beam of light?
We observe that the convex surface of the mirror is reflecting the light in the present case whereas in activity given above concave surface was reflecting So the behaviour of this mirror is just opposite to the concave one Due to reflective surface of the convex mirror it diverges all the rays instead of converging at a point Such beams are called diverging beams.

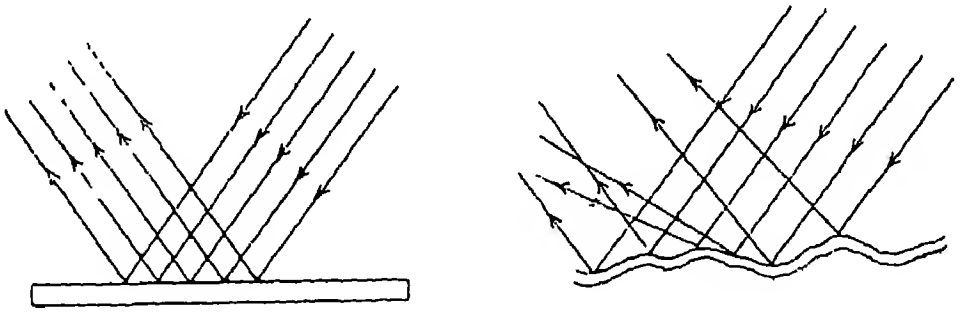
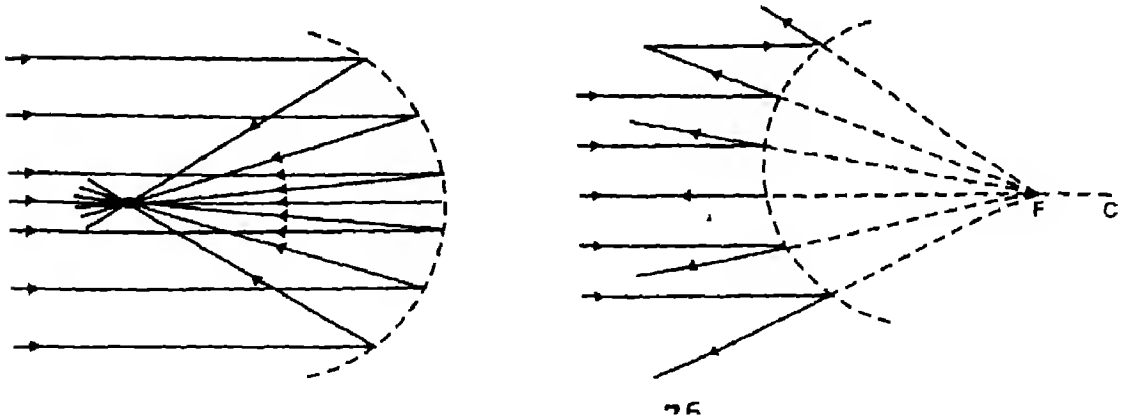


Fig. 25.18



Concept: When light is incident on a smooth polished surface, (1) The angle of incidence is equal to the angle of reflection. (2) The incident ray, normal at the point of incidence and reflected ray all lie in the same plane.

Material required: Ray streak apparatus, plane mirror, protractor (a paper protector)

Activity (i) Place the plane mirror in front of the ray streak apparatus. What do you observe?

Expected answer: The beams are reflected

Activity: (ii) Now change the position of the mirror

What happens to the reflected rays? The position of the reflected rays is changed

Activity: (iii) Keep all the streaks of the streak apparatus closed Only one streak should be opened Put the streak apparatus in front of sunlight Put the mirror on the paper protractor at $180^0 - 0^0$ line Adjust the beam of light at 90^0 positions

What do you observe? Where is the reflected ray?

Discussion Any beam of light when falls on the plane mirror it is reflected back Here also the ray which is normal to the plane mirror is reflected back in the same direction so it is not visible separately Now do other activities at different points of the mirror

Activity (iv) Now change the position of the ray streak apparatus from normal at any known angle Let (a) Angle between normal and incident beam = 30^0 or $\angle i = 30^0$ Where does the reflected ray come out?

Expected answer: It is coming out at 30^0 away from the normal on the other side What is the angle between the reflected ray and the normal?

Expected answer: 30^0, i e $\angle r = 30^0$. Make a table showing $\angle i$ and corresponding $\angle r$ Now repeat this activity with different values of $\angle i$ What do you observe?

Expected answer. In all cases $\angle i$ and $\angle r$ are equal

Discussion What is the relationship between $\angle i$ and $\angle r$? The incident angle is always equal to the angle of reflection This is called first law of reflection

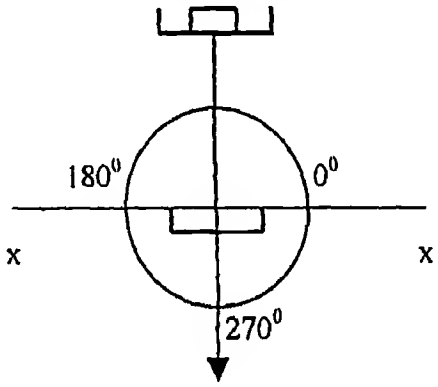
Activity (v) Repeat all above activities In which plane do the incident ray, the normal and the reflected ray lie?

Discussion: We observe that the incident ray, the normal, the reflected ray all lie in same plane (plane of the paper) It means the incident ray, normal at the point of incidence, reflected ray all lie in the same plane This is called second law of reflection

Refraction of light through glass slab

Concept: A ray incident normally on a glass slab passes undeviated

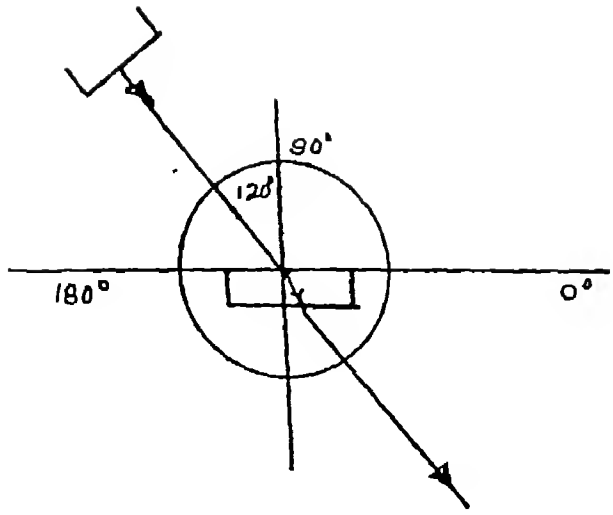
Material required: Ray streak apparatus, protractor, glass slab
Activity: Keep the glass slab on the $180^0 - 0^0$ line of a protractor as shown in figure and keep the ray streak apparatus (only one streak opened) in the sun such that the incident ray falls normally. What do you observe? Mark the incident ray and coming out ray (Emergent ray) Are these two rays in the same direction?



Expected answer They are in the same direction.
Discussion: If any ray falls normal to the plane of the glass slab it comes out through the glass slab without and deviation

Concept: A ray incident obliquely on a glass slab bends towards the normal

Material required Glass slab, ray streak apparatus, protractor
Activity: Now keep the ray streak apparatus in the sun, such that angle between the normal and incident ray is 30^0 as shown in figure. Now mark the position of the normal, point of incidence, incident ray, and emergent ray Join the point of incidence with the point where from the emergent ray comes out, to get the refracted ray within the glass slab. Measure the angle between incident ray and normal (angle of incidence) Measure the angle between normal and refracted ray (angle of refraction)

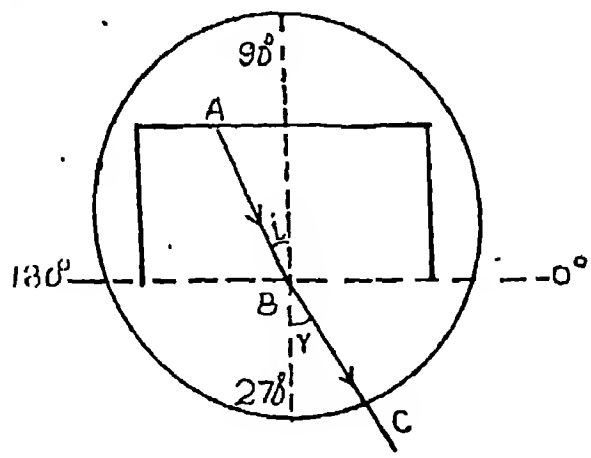


Discussion (i) Whether the incident ray and refracted ray are in same direction? (ii) Whether the angle of incidence and angle of refraction are equal? Repeat the activity for different angles of incidence.
Make a table of ∠r for different angles of incidence.

When any beam of light passes through glass slab making some angle then the refracted ray and incident ray are not in the same direction The refracted ray bends towards the normal so the angle of refraction is less than the angle of incidence.

Concept: An oblique ray coming out from glass slab to air bends away from the normal.

Activity: Keep the ray streak apparatus in the sun in such a way that the ray is visible inside the glass slab and strikes at B Measure ∠i and ∠r



Discussion. Name the incident ray and refracted ray in the present case Measure ∠i and ∠r in this situation? What do you conclude from the above results?

When any beam enters from air to glass the beam bends towards normal so ∠r will always be less that ∠i Similarly when any beam enters from glass to air, it moves away from the normal at the point of incidence So ∠r is always greater than ∠i

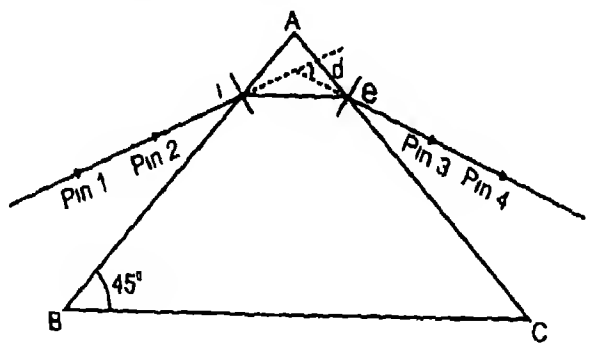
Concept: Ratio of sin i/sin r is constant for a given pair of media.

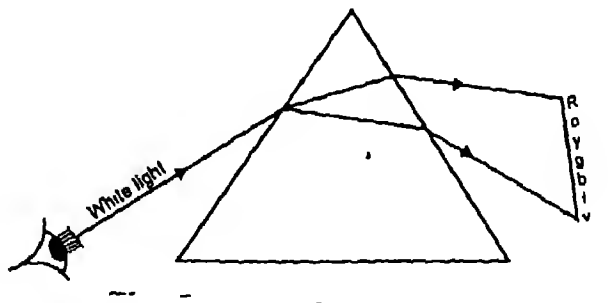
Activity: Ask the students to determine ∠r for different angle of incidence and calculate sin i/sin r. what do the observe? If a light ray goes from medium 1 to medium 2, the ratio sin i/sin r is constant and is known as Snell's law It also gives refractive index of medium 2 with respect to medium 1. Reciprocal of this value is known as refractive index of medium 1 with respect to medium 2

Refraction of light through a glass prism

Concept: White light on passing through a glass prism splits into seven colours

Activity: Take a prism. Ask the students to draw the path of rays through the prism making use of (i) all pins on the two sides of the refracting surfaces (ii) the principles given above. Now allow light to fall on one of the refracting surfaces Ask the students to look from the other refracting surface Let them adjust the prism and their eyes in such a way that different colours are observed Explain the splitting of white light making use of diagram. The terms 'Dispersion of light' and 'Spectrum' can then be introduced Ask the students to explain the formation of rainbow



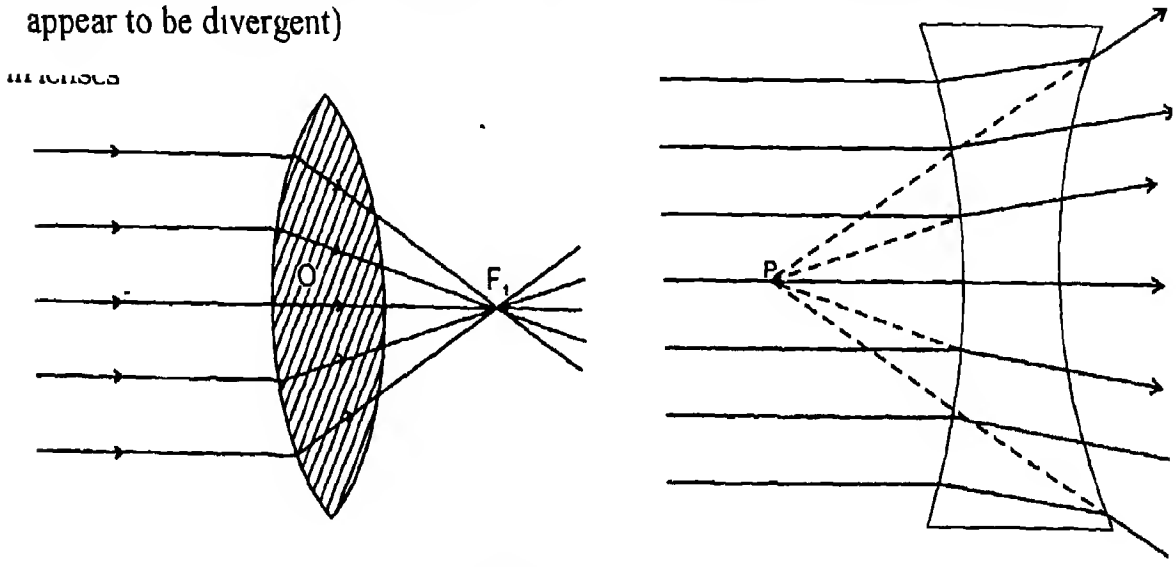


Refraction of light through lenses

Concept: Convergent and divergent beams can be obtained using convex and concave lenses respectively.

Material required Ray streak apparatus, convex and concave lenses.
Activity Keep the ray streak apparatus in sun light and obtain a parallel beam of light Allow the beam to fall on the (i) double convex lens (ii) double concave lens (made out of two plano – concave lenses given)

Discussion: What is the nature of the beam coming out of the double convex lens? The streak appears to be converging to a point Similarly, discuss what happens to the streaks coming out of the double concave lens? (the streaks appear to be divergent)



Concept: (i) The point where a beam of parallel rays incident on the convex lens meets on its other side after refraction is called focal point or focus. (ii) the distance from the centre of the convex lens to its focal point is called the focal length of the lens.

Material required: Convex lens, meter scale and paper screen.
Activity: Allow the light coming from a distant object (considered to be at infinity) or sunlight to fall on a convex lens Obtain a well-defined image on the paper screen kept on the other side of the lens
Discussion. (i) What is the nature of the beam coming from a distant object? (parallel beam)
(ii) What is the distance between the centre of the lens and the paper screen called when a well-defined image is obtained on the screen? (focal length)

(iii) What name is given to the point where parallel beam after refraction is converging? (This point is denoted by the letter F)

It can also be pointed out to the students here that reciprocal of focal length of a lens in metres is known as power of the lens in dioptres

Concept: Position of the image formed by a convex lens depends on the distance between the object and the lens.

Material required: Convex lens, meter scale, paper screen and candle.
Activity: (i) Determine the focal length as given in the above activity
(ii) Arrange the meter scale on a table and keep the convex lens at about its centre. Mark distances f and 2f on the table on either side of the lens
(iii) Keeping the position of the lens fixed, find out the position of the well-defined image on the paper screen when the candle is kept at the following distances from the lens on its other side

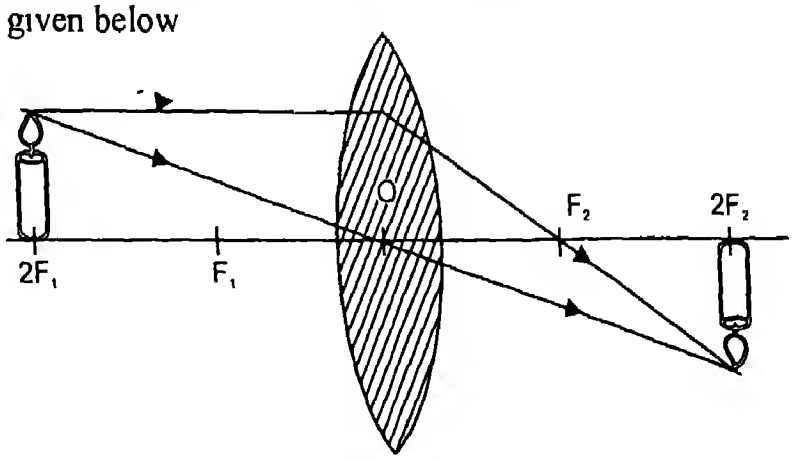
(a) beyond 2f
(b) 2f
(c) between 2f and f
(d) f
(e) within f

(iv) Prepare a table as given below:

S No	Distance of the candle (object) from the lens	Distance of the image from the lens	Nature of the image (erect or inverted)	Magnified or diminished

Discussion How does the image distance vary when the object is moved closer and closer to the lens? (While the object distance decreases, the image distance increases) Why don't we get an image on the screen when the object is placed at a distance f? Do we get an image on the other side when the object is placed within a distance f?

Make the ray diagrams as given in the textbook for each of the above cases. One such diagram is given below



Concept: A parallel beam of light incident on a concave lens appears to diverge from a point known as focal point of the concave lens.

Material required Concave lens, ray streak apparatus
Activity Keep the ray streak apparatus in sunlight and obtain a parallel beam of light. Allow this parallel beam of light to fall on the double concave lens

Discussion: What do you observe? If you extend this divergent beam of rays coming out of the concave lens backwards, what do you notice? (They appear to diverge from a fixed point known as focal point of the lens)
What do we call the distance between the focal point and centre of the lens). (focal length of the lens)
If the object is located at a very large distance from the lens, where will the image be formed?
(At the focal point of the lens).

Construct the ray diagram for an object situated at a very large distance from the lens If you place a paper screen at the focal point of the lens, do you obtain the image of a distant object on the screen?
(You will notice that the image can't be obtained on the screen, hence the image formed is said to be virtual)

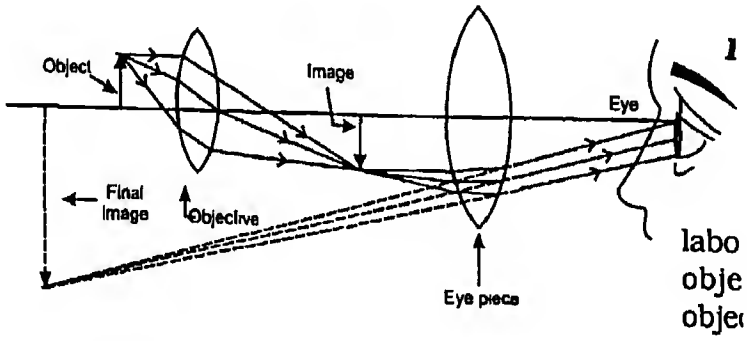
Concept: Magnification is equal to the ratio of size of image to the size of object or alternately the ratio v/u.

Activity: Ask the students to examine ray diagrams as regards size of image and that of object They will notice that the image may be larger or smaller

in size than the object Define here that the ratio of size of the image to that of object is known as magnification This is also defined as being equal to v/u which can be verified making use of geometrical relationship in the ray diagrams

Concept: Microscope is used to view small objects.

Activity: Take a reading lens Use it to show that how the small objects can be viewed and small divisions on some scale can be seen Next take a compound microscope Explain the terms objective lens and eye piece Focus a small object and show to the students that small details, which are not visible to the naked eye, can now be seen with the help of compound microscope Draw the ray diagrams with the help of students



labo
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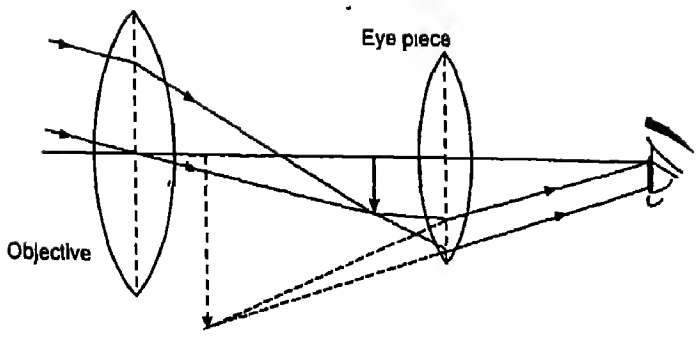
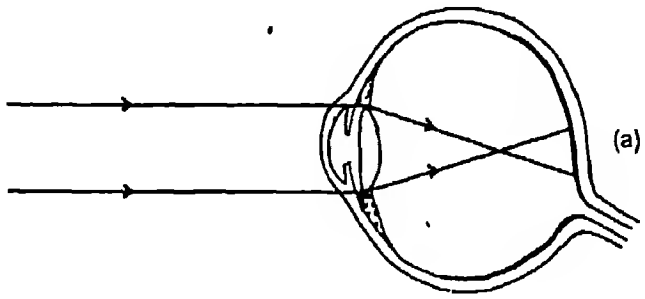
Concept: Telescope is used to view distant objects

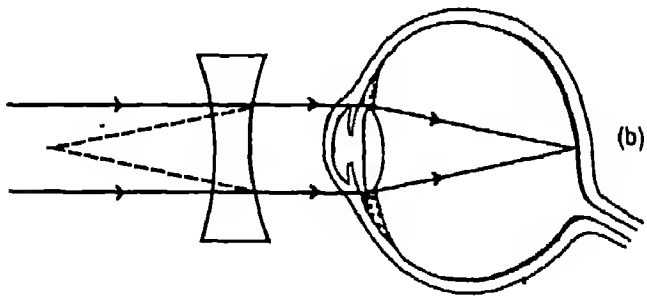
Take a telescope. Explain its construction using the terms objective lens and eye lens Now focus some distant object and draw the ray diagram



Concept: Myopic persons can see the near objects clearly but not the distant objects.

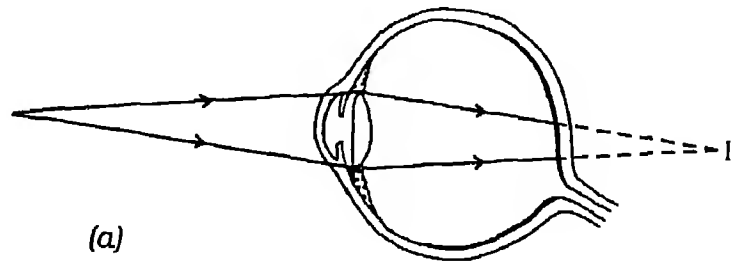
Explain with the help of the following diagram that in case of some persons, the image of distant objects is formed before the retina. To get the image on the retina, again show using the ray diagram as to how concave lens can be used to achieve the same. Explain that as the concave lens diverges the rays, it brings the rays to focus on the retina



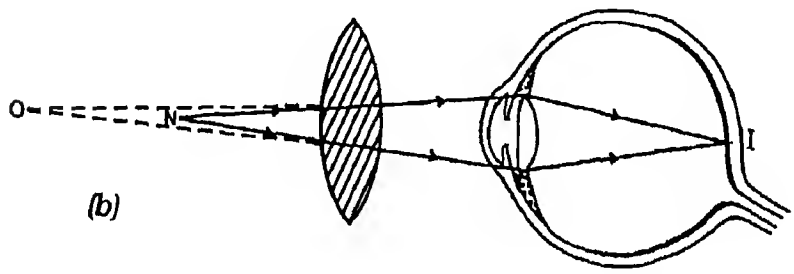


Concept: Hypermetropic persons can see the distant objects clearly but not the near ones.

Explain with the help of the following diagram that in case of some persons the image of the near object is formed behind the retina To bring it to retina, show using ray diagram as to how convex lens can be used to correct this defect



(a)



(b)

Magnetism and Electricity
Class VIII

Dr. S. V. Sharma
Lecturer in Physics

1. Overview

Around 800 B C , mineral was discovered in the town of Magnesia, which had wondrous properties This mineral was called magnetite after the place of its origin It attracted pieces of iron towards itself Even stranger, a thin strip of this material always aligned itself in the same direction, if left to rotate freely For this property it was given the name, the leading stone or Lodestone Such materials were later found to be composed of oxides of iron and are now called magnets.

Fundamentals of magnetism are magnetic fields and their effects on matter, as, for instance, the deflection of moving charges are torques on other hand magnetic objects. Euiderce for the presence of a magnetic field is the magnetic force on charges moving in that field, the source is at right angles to both the field and the velocity of the charge This force deflects the particles without changing their speed. The deflection can be observed in the electron beam of a television tube when a permanent magnet is brought near the tube. A more familiar example is the torque on a compass needle that acts to align the needle with the magnetic field of the earth The needle is a thin piece of iron that has been magnetized – i e , a small bar magnet. One end of the magnet is called North Pole and the other end south pole. The force between a north and a south pole is attractive, where as the force between like poles is repulsive The magnetic field is sometime referred to as magnetic induction or magnetic flux density, it is always symbolized by B Magnetic field is measured in units of tasla (T) The magnetic field lines always close on themselves, so that if they enter a certain volume at some point, they must also leave that volume A fundamental property of a magnetic field is that its flux through any closed surface vanishes (A closed surface is one that completely surrounds a volume) In this respect, a magnetic field is quite different from an electric field Electric field lines can begin and end on a charge, but no equivalent magnetic charge has been found in spite of many researches for so called magnetic monopoles The most common source of magnetic field is the electric current loop. A particle with a magnetic dipole moment is often referred to as a magnetic dipole. When placed in an external magnetic field, a magnetic dipole can be

subjected to a torque that tends to align it with the field, if the external field is not uniform, the dipole also can be subjected to a force All matter exhibits magnetic properties to some degree When placed in inhomogeneous field, matter is either attracted or repelled in the direction of the gradient of the field Certain materials, such as iron, exhibit very strong magnetic properties because of the alignment of the magnetic moments of their atoms within the certain small regions called domains Under normal conditions, the various domains have fields that cancel but they can be aligned with each other to produce extremely large magnetic fields Various alloys of technological importance, like NdFeB (an alloy of neodymium, iron and boron), keep their domains aligned and are used to make permanent magnets Since aligning the domains of a material produces a magnet and disorganization of the orderly alignment, destroys the magnetic properties of the material

Electrons in atoms have a magnetic dipole moment that corresponds to the current of their orbital motion around the nucleus In addition, the electrons have a magnetic dipole moment associated with their spin The Earth's magnetic field is thought to be the result of currents related to the planet's rotation The magnetic field far from a small bar magnet is well represented by the field of a magnetic dipole. In most of these cases, moving charge produces a magnetic field B, which imparts a force on moving charged particles The entire electromagnetic force on a charged particle with charge q and velocity V is called the Lorentz force All matter exhibits magnetic properties when placed in an external magnetic field Even substances like copper and Aluminum that are not normally thought of as having magnetic properties are affected by the presence of a magnetic field Depending on whether there is an attraction or repulsion by the pole of a magnet, matter is classified as being either paramagnetic or diamagnetic, respectively A few materials notably iron, show a very large attraction toward the pole of permanent bar magnet, materials of this kind are called ferromagnetic. In this module the concepts related to magnetism and electricity are discussed with appropriate teaching methods to be used in classroom situation However, this module is an exemplary one Exemplar activities suggested can either be demonstrated by the teacher or performed by the learner

2. **Objectives:** After going through the module you will be able to help the Learners to

- ❖ to discover that iron is the common material that sticks to magnets,
- ❖ perform activities with magnets,
- ❖ investigate variables that influence the force of attraction between two magnets,
- ❖ to detect the presence of magnet,
- ❖ infer that like poles of two magnets repel and unlike poles attract,
- ❖ distinguish between conductors and insulators,
- ❖ investigate current electricity circuits,
- ❖ demonstrate an ability to connect a simple circuit,
- ❖ recognize that electricity is a form of energy,
- ❖ explain some ways of conversion of electricity into other forms of energy,
- ❖ learn about the technological applications of electricity and magnetism in making the electrical appliances(simple electric bell) and devices (electromagnet),
- ❖ Understand the potential hazards when working with electricity and magnetism,

3. **Major teaching points/concepts**

The concept covered are as follows

- ❖ a freely suspended magnet aligns along a north – south direction,
- ❖ like poles of two magnets repel each other but unlike poles attract,
- ❖ the difference between a simple iron piece and a magnet is due to the arrangement of their magnetic domains;

- randomly oriented magnetic domains in a piece of iron get aligned under the influence of magnet field,
- current carrying wire can behave like a magnet,
- use of electricity to make an electro magnet,
- conversion of Chemical energy into electrical energy is done by cell,
- difference between conductor and insulator is due to flow of charges,
- when a conductor is moved in a magnetic field a current begins to flow in that conductor,
- electromagnetic induction;
- technological applications of electricity and magnetism.

4. Exemplar activities

Concept: Freely suspended magnet aligns itself along a north south direction.

Activity No. 1

- Suspend a magnet from a string tied to its middle
- Mark the direction in which is comes to rest
- Turn the magnet gently by your hand to point it in another direction and leave it
- Observe the direction in which it finally settles
- Notice that a bar magnet always comes to rest along the north – south direction

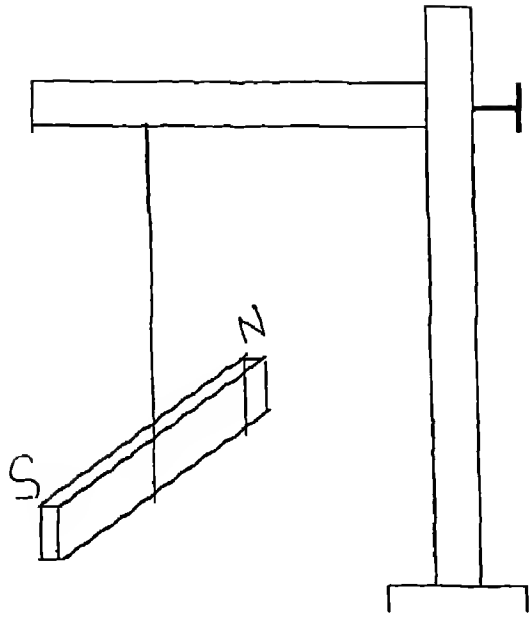


Fig 1

Can this activity be performed with the help of a horseshoe magnet? Discuss it.

Concept: Like poles of two magnets repel each other and unlike poles attract

Activity No. 2

- Take two bar magnets
- Suspend one of these by a string at some distance away from the second one
- Mark its north and south poles
- Now suspend the other bar magnet and similarly, mark its north and south poles
- Leave this bar magnet, suspended
- Now, hold the first magnet in your hand and bring its north pole close to each pole of the suspended magnet One by one (Fig 2)
- Observe it

- ❖ Repeat the same experiment now with the south pole of the bar magnet held in your hand
- ❖ Observe that the north poles of the two magnets repel one another
- ❖ The same is true for their south poles However, the north pole of one attracts the south pole of the other and vice-versa

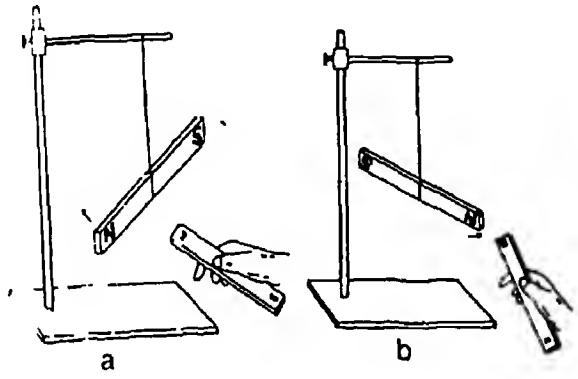


Fig. 2

Is this similar to the behaviour of forces experienced by electric charges; (Like charges repel each other and unlike charges attract)? Discuss it.

Concept: Difference between a simple iron piece and a magnet is due to arrangement of magnetic domains.

Activity No. 3

A large bar magnet is made up of small magnets each with its north and south poles The inside of a magnet can be studied using a very powerful microscope (electron) When viewed under such a microscope following a

special technique, a magnet is found to consist of small regions known as **DOMAINS.** Each of these domains is a tiny magnet and all these magnets point in the same direction (Fig 3a) An ordinary piece of iron is also made up of such small magnets or magnetic domains However, in a piece of iron, these small magnetic domains, point in different directions (Fig 3b) If we bring a magnet close to this piece, the small magnets inside the iron piece, slowly turn and align themselves As the magnetic domains align themselves in the same direction they reinforce each other's effect This piece of iron thus behaves like a magnet itself, with its south pole near the north pole of the magnet It is, therefore, attracted towards it It is this aligning of the small magnetic domains in ordinary iron objects like a nail, that causes them to be attracted by magnet When the magnet is removed, the small magnets inside the nail get jumbled again and the nail loses its magnetic properties Such a nail or iron piece is said to be a **TEMPORARY MAGNET.** However, if the magnet is strong enough, it can permanently align the small magnets inside the iron piece These small magnets inside will then remain aligned even when the influencing magnet is removed. Such a piece is called a **PERMANENT MAGNET.** Pieces of iron or steel can be magnetised permanently by repeatedly **STROKING** them with a strong magnet due to alignment of randomly oriented magnetic domains of iron piece (Fig 3c)

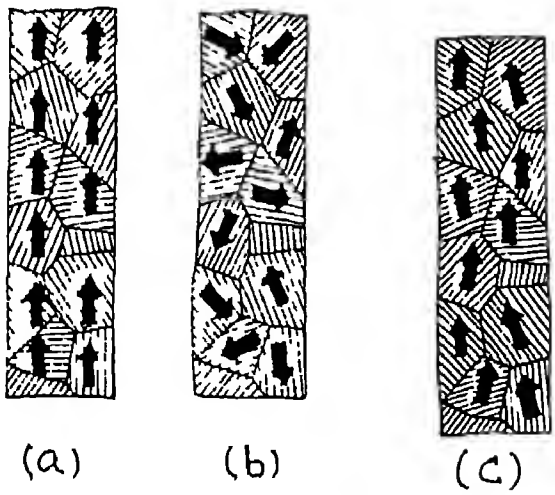


Fig 3

Can magnetic poles by isolated? Give remark.

Concept: Current carrying wire can behave like a magnet.

Activity No. 4

- ❖ Fix a wire along the edge of a table
- ❖ Place a magnetic compass near the wire (Fig 4)
- ❖ Connect the two ends of the wire to a battery cell and observe
- ❖ Place the compass at different points on the table at varying distances from the wire
- ❖ Observe the deflection in each case

You must have guessed from this activity that a current carrying wire behaves like a magnet When the current is stopped, the associated magnetic property also vanishes

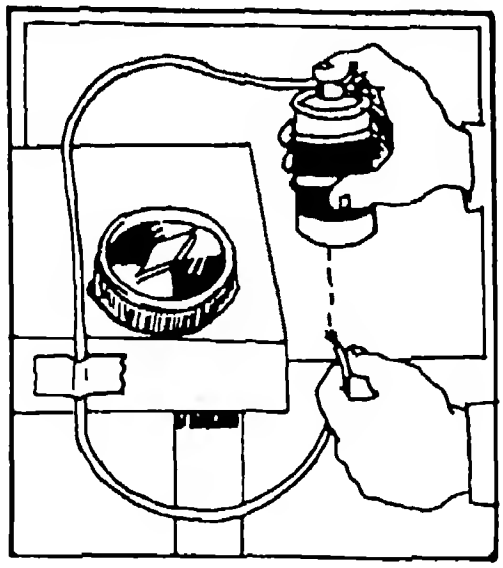


Fig. 4

Concept: Application of Electromagnetic induction i.e. making of an electromagnet.

Activity No. 5

To make an electromagnet, wrap insulated copper wire around a large nail about 20 to 30 times Remove a little of the insulation from the wire at both ends Attach these ends to the two poles of a dry cell battery You can make further your electromagnet stronger in two ways

- ❖ increase the number of turns of wire around the nail.
- ❖ attach a second dry cell by connecting the negative terminal of one battery to the positive of the second with a short piece of wire and connecting electromagnet wire ends to the remaining terminals on the batteries Your electromagnet pick up more than a regular bar magnet or horseshoe magnet or a temporary magnet How are electromagnets and permanent magnets, the same? different? Discuss and record in chart form below

Electromagnets	Permanent magnets

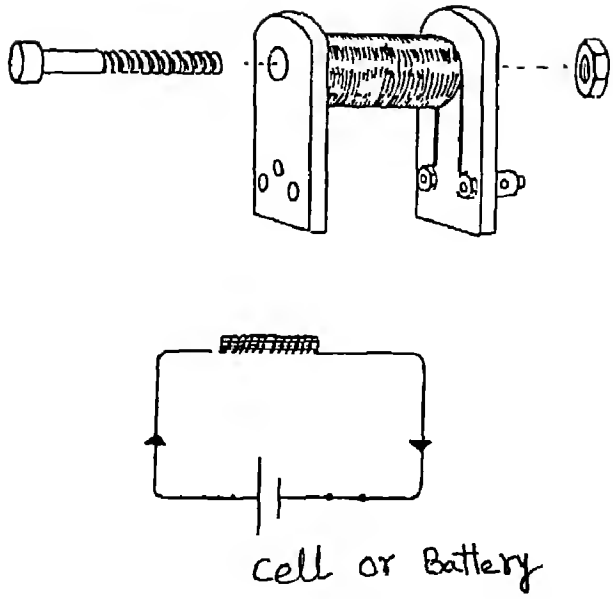


Fig. 5

Can electromagnet pick up pins, writing pen and paper pieces?

Concept : Difference between conductor and Insulator

Activity No. 6

- Create an electromagnet Attach more than one battery to make a strong electromagnet and/or increase the number of coils of wire around the nail Using known items that are attracted to the electromagnet (nails, pins, paper clips, etc), experiment with materials to be placed between the electromagnet and the attracted items Materials such as paper, cardboard, metals, plastic, glass, rubber should be tried Will the electromagnet attract through these? Are they conductors? insulators?

- Create electric circuit with a battery, three pieces of insulated copper wire, and a small light bulb in a holder (Fig 6)

- Attach the light bulb holder to one terminal of the battery cell with the first piece of wire Attach the other wires to the second terminal of the battery and the other terminal of the light bulb holder, leaving two free ends to use for experimentation Stress safety and have adult supervision for these activities Experiment with different kinds of metal –rolled foil, a nail, a spoon, a screw, paper clip, a piece of rubber, glass, cloth, plastic, etc Which are insulators? Which are conductors of electricity (the bulb lights up)?

- If your science room has strips of zinc, a small light bulb in a holder, and copper wires, you can create electrical circuit with carbon (from a pencil lead) and a lemon Push the strip of zinc into the lemon Attach the uncovered end of your wire to the zinc strip and the other end to one post of the light holder. Push the carbon rod into the lemon away from the zinc strip Attach a second wire to it. what happens when the other end of the wire is touched to the other post of the light holder? If necessary add a second lemon with a short piece of wire and another set of zinc and carbon

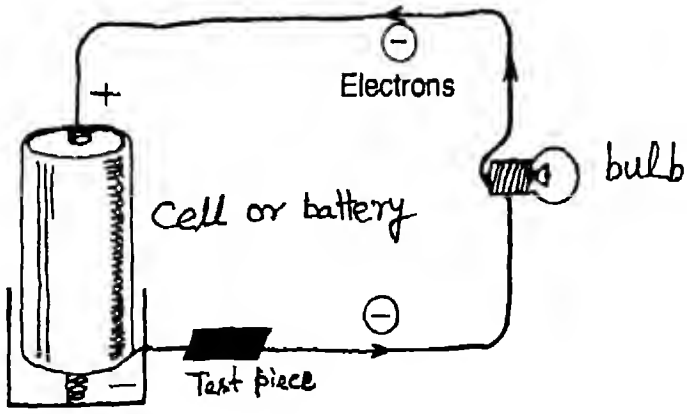


Fig. 6

Concept: Application of Electromagnet i.e. making of simple electric bell

Activity No. 7

When the switch is closed, the coil is energized and the hammer is pulled towards the core, striking the gong When it is opened, the magnetism ceases and the hammer returns to its original position because of its tension

- Fix the gong to the gong bracket with screw and assembly on the baseboard
- Fix a terminal to the hammer and fasten the hammer to the baseboard with screw
- Fasten the coil to the baseboard with the strip and screws
- Fix the switch to the baseboard as shown in fig. 7.
- Adjust the gong bracket so that the gong is about 1/16" from the hammer terminal.
- Make connections as in Fig 7, with the switch **OFF.**
- Switch on and adjust the position of the coil so that the hammer strikes the gong Switch off The hammer springs back When switched on, the hammer again strikes the gong The bell is thus operated with a switch If the switch is operated rapidly and regularly, a continuous ring can be heard

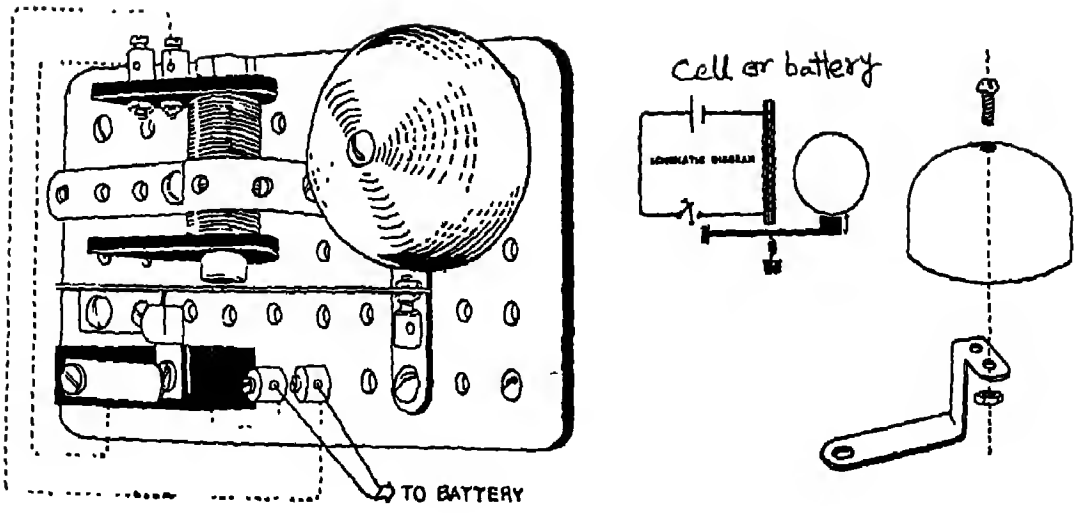


Fig. 7.

Can switch of electrical bell be kept pressing in on position for very long duration? Give reasons.

Concept: Uses of electricity & magnetism, sources of electricity & magnetism and Electrical hazards & safety.

Activity No. 8

Have learners in small groups in class, discuss and chart information on the topics of above concepts

For Group No. 1

Sources of electricity and magnetism

For Group No. 2

Technological applications of electricity & Magnetism

For Group No. 3

List of electrical hazards & safety

5. Testing of RLOs

- State examples of forces, which can act even at a distance
- How temporary magnet is different from a permanent magnet?
- Learners make inventory of things around the house that use electricity or magnetism
- Learners look inside broken electric and electronic appliances and devices to see some advanced circuits.
- What energy is converted to electrical energy in a cell?
- Find the various ways in which two batteries and two bulbs can be connected in a working circuit
- Discuss technological applications of electromagnetic induction in large-scale production of electricity
- Uncovered wire can give electric shocks comment on this.
- All electrical appliances should be properly earthed Give your remarks.

6. Common essential learning's & values developed

Communication, critical and creative thinking technological literacy, independent learning, personal & social values, skills and scientific attitude

7. Let us Sum up

- North poles point north, south poles point south.
- Like poles repel, unlike poles attract
- Magnetic forces attract only magnetic materials.
- Magnetic forces act at a distance

- While magnetized, temporary magnets act like permanent magnets
- A coil of wire with an electric current flowing through it becomes a magnet.
- Putting iron inside a current – carrying coil increases the strength of the electromagnet
- A changing magnetic field induces and electric current in a conductor
- A charged particle experiences no magnetic force when moving parallel to a magnetic field, but when it is moving perpendicular to the field it experiences a force perpendicular to both the field and the direction of motion
- A current – carrying wire in a perpendicular magnetic field experiences a force in a direction perpendicular to both the wire and the field.

8. References

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Work and Energy

Dr. H. C. Jain

Overview

The basic concern of this module is initially to explain closely associated concepts work and energy. It has several aspects, viz

- Meaning of work in mechanics is different than that of lay persons
- There are two kinds of energy Kinetic because of body possessing velocity and potential due to its position or condition
- Potential and kinetic energy are transformable into each other
- Energy can be changed from one form to another
- With the increasing consumption of energy, there is a need to harness alternate sources of energy.
- Sources of energy, its technology for use and the development of the society are closely related
- Emphasis on harnessing renewable sources of energy is to be given
- Judicious use of energy has to be made
- Steps are needed to protect environment from being excessively polluted

To begin with, discrimination has been made between laymen's and scientific meaning of work using daily life experiences. Then its association with energy possessed by a body because of its position and velocity has been discussed. Further, transformation of energy due to change in position or velocity has been illustrated using activities Thereafter, global energy scenario has been presented. Systems developed using different sources of energy for multifarious uses/benefits for the society have been enlisted Lastly, the steps for judicious use of energy have been mentioned

Objectives

After going through this module you will be able to help the learners to

- Define work and energy.
- Discriminate between potential and kinetic energy.
- Explain the transformation of potential energy into kinetic energy and vice-versa
- Comprehend the idea of conservation of energy

- Infer the need for search for alternate sources of energy.
- Identify the effects of energy consumption on environment.
- Recognize the potential of renewable and nonrenewable sources of energy.
- Relate sources of energy with systems developed using technology for the benefits of the society and improving the quality of life
- List judicious ways of saving energy

Concepts and Transactional Strategies

The following concepts have been discussed in this module.

- Work is equal to the force multiplied by the distance moved along the action of the force
- Potential energy is due to position and kinetic energy is due to motion of the body.
- Potential and kinetic energy are transferable into each other.
- Total energy of any system is conserved
- Development of Technology has helped in designing several systems using different sources of energy for multifarious social needs.
- Energy consumption is increasing fast.
- Scientific phenomena coupled with technology can meet the energy demands of the growing society.
- There is need for harnessing Renewable Sources of Energy to meet energy demands.
- More use of energy has led to environmental pollution.
- Energy is precious and should not be wasted.

Concept - 1 Work is defined as the force multiplied by the distance moved along the action of the force.

Sub-Concept: Meaning of work in everyday life and mechanics are different.

Transactional Strategy

It is well known that in every day life work means any physical activity or doing something. Also if a force is applied, work is considered as being done. In this sense, pushing a wall, drawing water from a well, fixing a nail in the wood with the hammer, a labourer lifting bricks from the ground

and putting them on his head breaking a stone etc. are all examples of doing work Ask the students to (a) give some more examples where they consider that the work is done and (b) explain the direction of force and the distance moved in each case. They will notice that in some cases the distance moved in zero, while in others distance moved depends upon the force applied. Similarly, they will notice in some cases the force and the distance moved are in the same direction while in others it is not the case.

Extend the discussion further by showing the following three situations as given in the diagram.

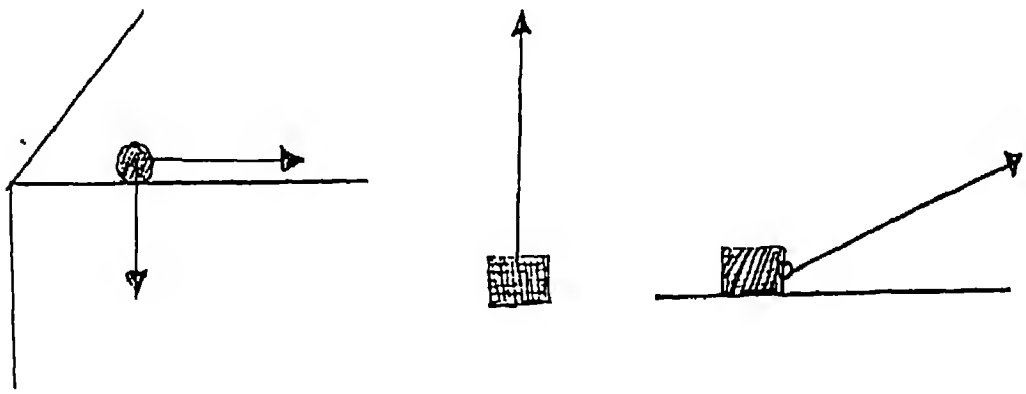


Fig. – 1: Force acting on bodies in different situations

(i) A body moving over a smooth horizontal surface.
(ii) Lifting a stone or a brick vertically up for some distance.
(iii) A body being dragged by a rope inclined at some angle to the body.

Put the following questions:

- Is there any motion of the body in the direction of gravitational force in the first case while this force is continuously acting over it?
- Is the point of application of lifting the brick changing in the vertical direction in the second case?
- Is the point of application of the force by the rope in the third case having any of its components in the direction of movement of the body?

While the application of gravitational force does not affect the motion of the body in the first case, point of application continuously changes in the second case as the brick is lifted up and the force has a component in the direction of movement of the body in the third case.

According to layperson work is done in all the three cases given above. However, concept of work in Physics is different. Work is considered to be done when the point of application moves in the direction of the force applied or force has a component in the direction of movement of the body Thus, it can be inferred that work is done in the second and third situation but not in the first one In other words, force and the motion together play an important role in defining work. In view of this, the product of the magnitude of force (F) with the distance moved along the action of the force is defined as work (W). Alternatively, product of the component of the force in the direction of the distance moved with the distance is also characterised as work.

Mathematically, Work done (W) = $Fs \cos \alpha$

Where α is the angle between F and s. it can be seen from the above expression that whenever the direction of the force applied and the distance moved are perpendicular to each other, no work is done by the applied force. If the force is measured in Newton and distance in metre, the unit of work is Newton Metre known as Joule. Rate of doing work i.e. work done in unit time is termed as power and measured in Watt (Joule/second). Power is also measured in a unit called 'Horse Power' which is equal to 746 Watt.

Check your progress - I

(i) Is any work done by the gravitational force when a body falls vertically downwards? Give reason.

(ii) Is any work done by a man in carrying the bricks on his head and moving a distance? Give reason.

(iii) Is any work done in whirling around a ball in a circular path? Give reason.

Concept - 2 Bodies possess energy by virtue of their position, deformation and motion.

Transactional Strategy

Consider the following situations.

(1) A hammer or a big stone is held at a height Is it in a position to do the work of breaking a small stone when released over the smaller stone?

(2) Can water held at a height (e.g. in a dam) by virtue of its position and on allowing it to fall do the work of moving something e g. the blades of a turbine

(3) Can a wound up spring make the hands of a clock move?

(4) Can a cell connected in a calculator or a watch make it to do the work.

You will notice from the above examples that a body because of its position or condition has the capacity of doing the work and that's why it is said to possess energy termed as potential energy.

Consider another situation Hold one end of a spring with your hand and connect a weight to its other end. By compressing or elongating the spring on raising or lowering the weight respectively and releasing it, what do you observe and why? The weight moves up and down indicating that a deformed body also acquires the ability to perform work. So it also possesses potential energy.

You can, therefore, conclude by giving such examples to the students that if the objects/bodies can do the work by virtue of their position or deformation, they possess potential energy.

Consider again what happens to these bodies when potential energy is set free e.g. by releasing a stone or allowing water to fall from a height or releasing a compressed or elongated spring? They come in motion or in other words, they gain velocity. A bullet when fired vertically up against gravity also leaves the barrel with high velocity against gravity In all such cases, the objects or bodies are capable of doing work after they acquire velocity. A moving or falling stone can break another stone, falling water

can move the turbine, compressed spring can perform work against forces of elasticity by displacing any object from its position and a moving bullet rises and performs work against the force of gravity. These works are made possible because the objects/bodies have definite velocity and not because they occupy a definite position at the time of doing the work. Each time, work is done velocity gets reduced. When velocity becomes zero, the ability to perform work is exhausted It means that any moving object/body has certain energy due to its motion. This energy in motion is known as kinetic energy. Similarly, a stationary body irrespective of its position when given a push or pull and coming in motion in considered to have acquired kinetic energy

Mathematically (consult text-book), potential energy of a body having mass M and at a height h from the ground is given by Mgh. Similarly, a body having mass M moving with velocity v has kinetic energy equal to $\frac{1}{2}$ mv^2. Both potential and kinetic energy are measured in the unit 'Joule'. Thus, if a body falls under the action of gravitational force, its potential energy decreases as height from the ground (h) decreases. On the other hand, the velocity of this falling body increases. As kinetic energy depends upon velocity, its value increases with increasing velocity.

At any point, total energy is the sum of potential and kinetic energy as seen above. For a falling body while potential energy decreases, kinetic energy increases. What inferences can be drawn from it?

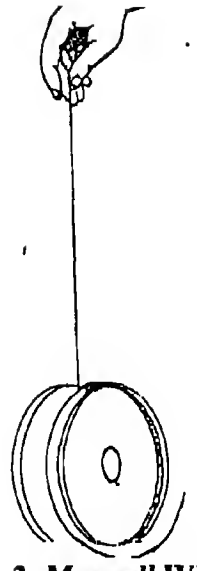
(i) There is transformation of potential energy into kinetic energy.

(ii) Total energy at any point of time remains constant. This is known as conservation of energy.

Concept - 3 Potential and kinetic energies are transferable into each other.

Transactional Strategy

Take the Maxwell wheel with one end of a long thread tied at the centre of the axle. Wind the thread around the axle and hold its other end with one hand and wheel by another hand. Remove your other hand an allow the wheel to roll down Initiate the discussion with the students as follows:



Which energy did the wheel have initially?
Potential energy because of its position
What happens to this energy when the wheel rolls down?
Potential energy decreases
Into which form is this energy converted while rolling do
Kinetic energy

Fig. – 2: Maxwell Wheel

What happens to the wheel and thread when all the turns of the thread are unwound?
Thread gets wound back on the axle and the wheel rises up
What does it indicate?
Kinetic energy is now getting transformed into potential energy.

As this process is repeated again and again, explain that the transformation of potential energy takes place into kinetic energy and kinetic energy, into potential energy and so on while the total energy remains the same at any point. (Note The wheel may not rise back to the same initial position in subsequent steps because of loss of energy due to friction etc)

Concept – 4 Energy can be changed from one form to another.

Transactional Strategy Prepare a diagram/chart like the one given below and explain the various steps to the students

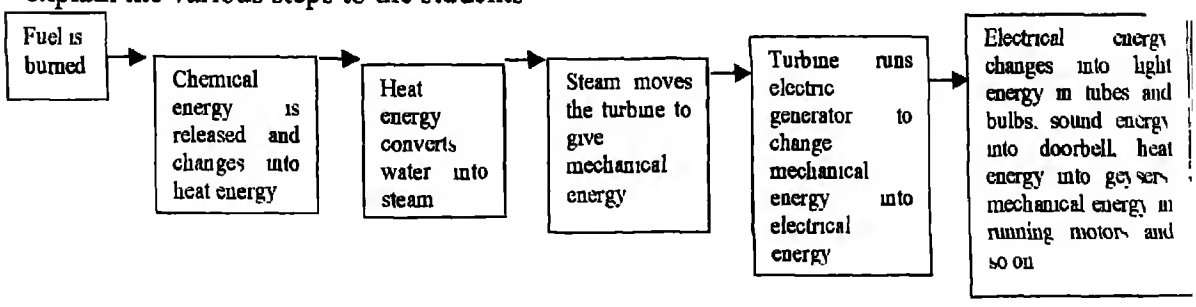


Fig. – 3: Transformation of energy from one form to another

Infer here that energy is neither created nor destroyed but changes from one form to another. This is the law of conservation of energy.

Check your progress - II

(i) Which are the different forms of energy? Give one example of one of them.

(ii) If law of conservation of energy is valid, what happens to potential and kinetic energies when a falling body hits the ground?

Concept - 5 Potential energy of an oscillating simple pendulum changes to kinetic energy and back again.

Transactional Strategy

Make a simple pendulum using a stand, bob and the thread as shown in figure

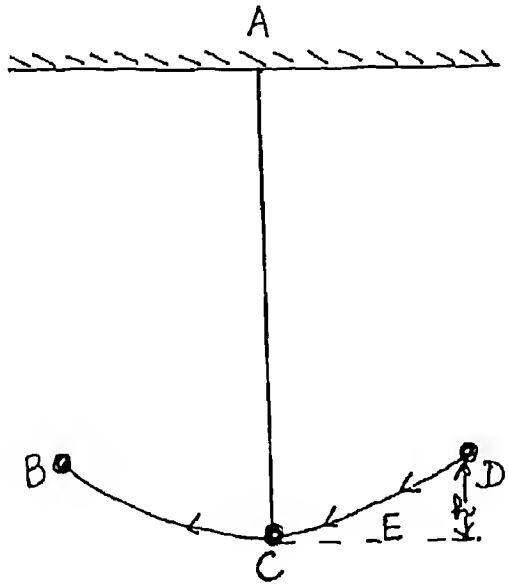


Fig. – 4: An oscillating simple pendulum

Discuss the following steps with the students

(i) How much is the potential energy of the pendulum at the point D with respect to the point C (Ans Mgh)

(ii) How much is the kinetic energy of the pendulum at the point D (Ans: Zero because the pendulum is not in motion)

(iii) What are the potential and kinetic energies of the pendulum at the point C
(Ans Zero and ½ mv^2 respectively)

(iv) What has happened to potential energy when the pendulum goes from D to C

(Ans: Potential energy is transformed into kinetic energy.)

(v) Which energy or energies the pendulum has at any point E between D and C
(Ans.: Both potential energy and kinetic energy)

(vi) What happens to potential and kinetic energy when the pendulum goes from C to B, B to C, C to D and then again from D to C and so on.

(Ans · Kinetic energy is transformed into potential, potential into kinetic, kinetic into potential, potential into kinetic respectively and so on)

Check your progress - III

Is it possible for a body to have both potential and kinetic energy at the same time? Explain your answer.

Concept -6: Development of Technology has helped in designing several systems using different sources of energy for multifarious social needs.

Transaction Strategy

Ask students to prepare a list of sources of energy and their use as illustrated here.

Source of energy	System using technology	Uses/benefits for the society
Coal	Angithi Thermal power plant	Cooking the food, heating the houses. Electricity is used in offices, household appliances, agricultural practices and industries.
Oil	Lantern, Stoves Engines, Automobiles Generators	Lighting the houses. Cooking the food, transportation. Electricity produced is used for several works in houses and industries.
Gas	Gas burners Auto vehicles	Cooking the food ,heating, industries, transportation.
Bio fuels	Gobar gas plants Pyrolysis plants	Gas produced is used for heating and cooking
Wood	Smokeless Chulas	Used for cooking , heating etc.
Wind	Windmill Aerogenerators	Flour mills, electricity produced is used for lighting

Falling water	Dams turbines	Centralized hydropower, hydropower stations supply electricity to villages and cities for use in various fields such as agriculture, industries and household jobs, offices etc.
Oceans Tides Waves Sea weeds Thermal gradients	Tidal power plants Salter Duck Processing plants Ocean Thermal Energy Conversion (OTEC) plants	Hold promise for generation of electricity in coastal areas. Fertilizers are obtained besides getting methane.
Earth's interior	Geothermal energy plants	Hold promise for generation of electricity in Geothermal Regions.
Nuclear fuels	Nuclear power plants (Nuclear Reactors)	Centralised power stations supply electricity to villages and cities for use in various fields like agriculture, industries and household jobs.
Sun	Collectors of various kinds, solar cookers, solar cells	Heating the houses, solar ponds. Solar stills, refrigeration systems, water pumps, driers. Cooking the food, watches, calculators, electricity produced is used for doing several jobs e.g. drawing water from well to power spaceships, satellites etc.

Concept - 7: Scientific phenomena coupled with new energy technology can help in meeting energy demands of the growing society.

Transactional Strategy

You can use simpler examples for students. The discussion given here will help you to think critically. You can also ask students to organise a debate on this issue. It is seen that there are several sources of energy. These are used in different ways. The quantum of use of energy in all forms including electricity all over the world obviously depends upon population living on earth Advancement in science and technology pertaining to energy should pave the way for progress of civilisation in all walks of life. For example, transport means are fast improving. However, the use of automobiles is criticized for adding to air pollution. Production of fuel like CNG in sufficient quantity is, therefore necessary. Similarly use of LPG for cooking can lead to less pollution and is fast replacing the conventional fuels

like coal, oil and wood. The high quality energy source is not only necessary for vehicular transport but also for railways, ships and aeroplanes It is obvious that the development of transport facilities helps in extension of international business, educational, cultural and social contacts and cooperation and hence to a large-scale exchange of information.

Comfort has become a necessity of life. To heat the houses in cold weather and to cool the same in hot weather requires energy More energy is also required for increasing agricultural output, water supply systems, cooking, household appliances, T.V. and Radio sets, computers, cinemas etc., as a part of improving the quality of life of human beings. Besides, industries energy is required to fulfill other needs of the society. All this has become possible by using technology for giving high-grade energy used in the form of electricity with provisions made for centralized generation and distribution among the users.

As a result, use of more and more energy resources is leading to increasing environmental pollution. This has put the society into a dilemma. Should we go on using the present energy sources at the expense of our environment? Or let us think only for preserving the environment. One option can be that we go on allowing the burning of coal and encourage off shore oil drilling without thinking of the environment. Second option can be that of finding new sources of energy but these are not immediately available. This requires a lot of research for finding out new sources of energy and in turn a lot of money as well. How countries particularly developing and underdeveloped can afford this? Answers to these questions are not simple. However, right now we can make a judicious use of energy. This pertains to changing our habits. Can we not pool our vehicles while going for work? Can we not use bicycles for small distances? Can architecture be improved to design buildings, which do not waste electricity? Can we not decide to use electric appliances in a more planned manner? At the same time, should we not replace use of petrol and diesel by CNG? Should we not stop burning coal and wood for cooking and use LPG? Should the industries not make use of devices minimizing pollution?

At the same time, the society, scientists and technologist cannot be satisfied with the existing traditional methods for converting different forms of energy into electricity. Conventional fuels, besides being limited are dissipated by burning Thermal power plants using coal have at best 40% efficiency Large among of by products contaminating the environment are

released in the process of fuel combustion Therefore, development of new energy techniques enabling reduction in waste matter to the atmosphere is a major problem to be tackled. Nevertheless for the time being to fulfil human needs thermal power plants using the present technology have to be there and constructed in spite of disadvantages.

Nuclear power plants were considered to be the option They have higher efficiency in terms of matter as compared to thermal power plants But while operating a nuclear power plant, heat is converted first into mechanical energy, which in turn is transformed into electricity by generators. It leads to losses and therefore, the main drawback characteristic of thermal power plants still persists. Mechanism for converting nuclear energy directly into electricity is still needed. The problem of finding suitable technology for safe disposal of radioactive wastes also need to be tackled Besides, while the proponents of nuclear energy consider it as a viable option, the opponents of nuclear energy consider it as a threat to the society in view of the fear of nuclear radiation, safety of nuclear power plants and the possibility of proliferation of nuclear weapon.

In the light of scantiness of fuels and new mechanism of conversion to be devised, the society should turn more towards using bio-energy, hydropower, tidal power, geothermal energy, wind energy and solar energy. In contrast to centralized power system fro thermal or nuclear power plants, there have to be decentralised small units. Use of bio energy, tidal power, geothermal and solar energy has to be done in fairly small units but over a large population keeping the location in mind. For example, technology of gobar gas plants giving bio-energy can be used in villages and its residue as manure, which helps in agriculture output. Tidal energy can be used in coastal regions. Use of smokeless chulahs can replace the traditional chulahs leading to environmental pollution. Geothermal regions can be located and accordingly energy from the interior of the earth can be used in such places. Similarly, solar energy available in plenty in many parts of our country if harnessed can be used in solar cookers for cooking the food, drawing water from the wells, heating the houses and drying the grains etc Using collectors can help in easing the situation of energy crisis as conventional fuels like coal, oil and gas in turn be saved. Developing suitable technology for desalinating seawater can also solve the problem of drinking water. All such uses can lift the standard of living of the masses without much difficulty.

Concept - 8: There is need for harnessing Renewable Sources of Energy to meet energy demands

Transactional Strategy

Here again, you must start with students' responses Ask students how renewable sources of energy can be used and reused to meet the energy demands In view of the above given projected requirements for power, it is obvious, that the dependence on non-conventional sources of energy including nuclear energy and renewable energy sources will increase At present (as of April 2000) nuclear share of electricity generation for India, China and Pakistan were respectively 2.65% (1895 MW), 1.15% (2167 MW) and 0.12% (125 MW). France tops the list of 75% (63103 MW) while in case of Canada, USA, UK, Japan and Brazil these figures respectively were 12.44 (9998 MW), 19.80% (97145 MW), 28.87% (12968 MW), 34.65% (43691 MW) and 1.25% (626 MW).

The importance of increasing the use of renewable sources of energy has been realised in our country since 1970. Entire gamut of technologies has been covered through various programmes. Emphasis has been given on development of improved chulhas, biogas plants, short rotation fuel wood tree species, biomass gasifiers, solar thermal and solar photovoltaic systems, wind farms, windmills, biomass based cogeneration, small and micro hydel systems, energy recovery from urban, municipal and industrial wastes, hydrogen energy, ocean energy conversion plants, fuel cells, and gasohol etc. Indeed, India is today amongst the countries of world having the largest programs for renewable energy as these can provide the basis for sustainable energy development on account of their inexhaustible nature and environment friendly features.

Concept - 9: More use of energy has led to environmental pollution

Transactional Strategy

Try to know student's existing concepts related to environmental pollution. Is environmental pollution related to energy use? If yes how? Initiate the discussion among students. Use of energy is essential for economical and social development to improve the quality of life. The world community has started to realise that no source of energy is risk-free and environmental considerations must be taken into account in our choice of sources of energy.

More use of fossil fuels has resulted into several problems affecting human life. These include greenhouse effect, air pollution, depletion of ozone and acidification of the environment. Out of these, greenhouse effect is considered to be the main potential threat. Greenhouse gases interfere with the natural process of heat exchange between the earth's atmosphere and outer space As a result, global climatic changes are taking place Carbon dioxide from burning of fossil fuels is the largest single source of greenhouse effect. Coal, oil and natural gas give most of the energy used to produce electricity, cook food, heat the houses, run automobiles, factories and industries. If the fuel is burned completely, the only by product would be carbon dioxide. But combustion is often incomplete, so, carbon monoxide and other hydrocarbons are also produced. Nitrous oxide and other nitrogen oxides are produced because fuel combustion causes nitrogen in the fuel or air to combine with oxygen in air. Extracting, processing, transporting and distributing fossil fuels also release greenhouse gases.

During the last ten years, worldwide debates concerning the impact of use of energy on the global climate system due to emission of greenhouse gases have been held Primarily the focus has been on carbon dioxide, methane, nitrous oxide and halogenated compounds, which contain fluorine, chlorine and bromine. Estimates indicate that 20,000 million tone (1 tone – 10^3 kg) of carbon dioxide and 65 million tons of sulphur are added to the atmosphere per year. These are considered to be of severe concern for living beings including the workers. It is, therefore, necessary to search technology for reducing emissions while using the fossil fuels. Strategies for reducing methane releases during fuel mining and during gas transmission are also relevant. Besides, in a global society, factories, industries and other organisations should do voluntary energy and environment audits on ethical grounds and act as world citizens. There should be common set standards by the government for safety, performance, and best industrial practices. These should be fostered by the government on all those who are responsible for creating situations for the change of environment. Besides, there should be more emphasis on the use of sources of energy such as wind energy, energy from oceans and solar energy since they contribute very little towards greenhouse effect etc

Concept - 10: Energy is precious and should not be wasted

Transactional Strategy

You may ask the students to give some of the ways, which can be used to save energy in daily life. With the help of pupil responses, you prepare a list as given below

i) Making use of tube-lights instead of light bulbs as tube light gives much more light than the light bulbs using the same amount of energy

ii) Using the public transport in place of individual vehicles as the former consumes less energy per head than the later.

iii) Switching off lights, fans, coolers and heaters when not in use.

iv) Closing water tap after use.

v) Fitting the washers suitably in water taps so that water does not leak out even after closing the tap.

vi) Driving the vehicle with not more than 40-50 Km/hour.

vii) Covering the vessels during cooking.

viii) Soaking the pulses for some time before cooking

Given below are some of the ways, which can be used to save energy in industries and agricultural practices

In industries

- Right proportion of air to burn the fuels should be used.
- Raw materials should be recycled
- By product fuels should be utilized
- Energy efficient machines should be used.
- Charcoal should be used in place of fuel and oil wherever possible

In agriculture

- Efficient water pumps along with the right size of pipes should be used.
- Appropriate use of fertilizers such as that of animals and plant residues should be made
- Renewable sources should be used.
- Solar photovoltaic systems should replace diesel systems

Reflective Questions

(1) Under which condition will the maximum work be done in moving a body to the same distance by the same force?

(2) If the kinetic energy of a given body increases sixteen times its initial kinetic energy, how much the velocity would have changed?

(3) If a ball of mass m at a height h from the ground is thrown upwards with velocity v and reaches upto the height 2h, how much will be the potential energy of the ball at that point?

(4) Explain what happens to kinetic energy of a falling body when it hits the ground.

(5) Discuss the transformation of energy of a swinging pendulum starting from one end and back to it.

(6) Prepare a list of conventional and non-conventional sources of energy

(7) What is energy crisis and how can it be solved?

Answers to Questions

Check your progress – I

(i) Yes, Distance moved is in the direction of gravitational force.

(ii) No, force and distance moved are perpendicular to each other.

(iii) No, there is no displacement in the direction of centripetal force.

Check your progress – II

(i) Mechanical energy, Heat energy, Light energy, Sound energy, Nuclear energy, Solar energy, Chemical energy, Electromagnetic energy.

(ii) Potential energy gets transformed into kinetic energy as the body falls. At the ground level potential energy becomes zero and kinetic energy is lost in the form of sound energy, light energy and heat energy.

Check your progress – III

Yes, depending upon position and velocity the body will have potential and kinetic energy respectively.

Answers to Reflective Questions:

1 Maximum work is done when the applied force and the distance moved are in the same direction

2. Four times.

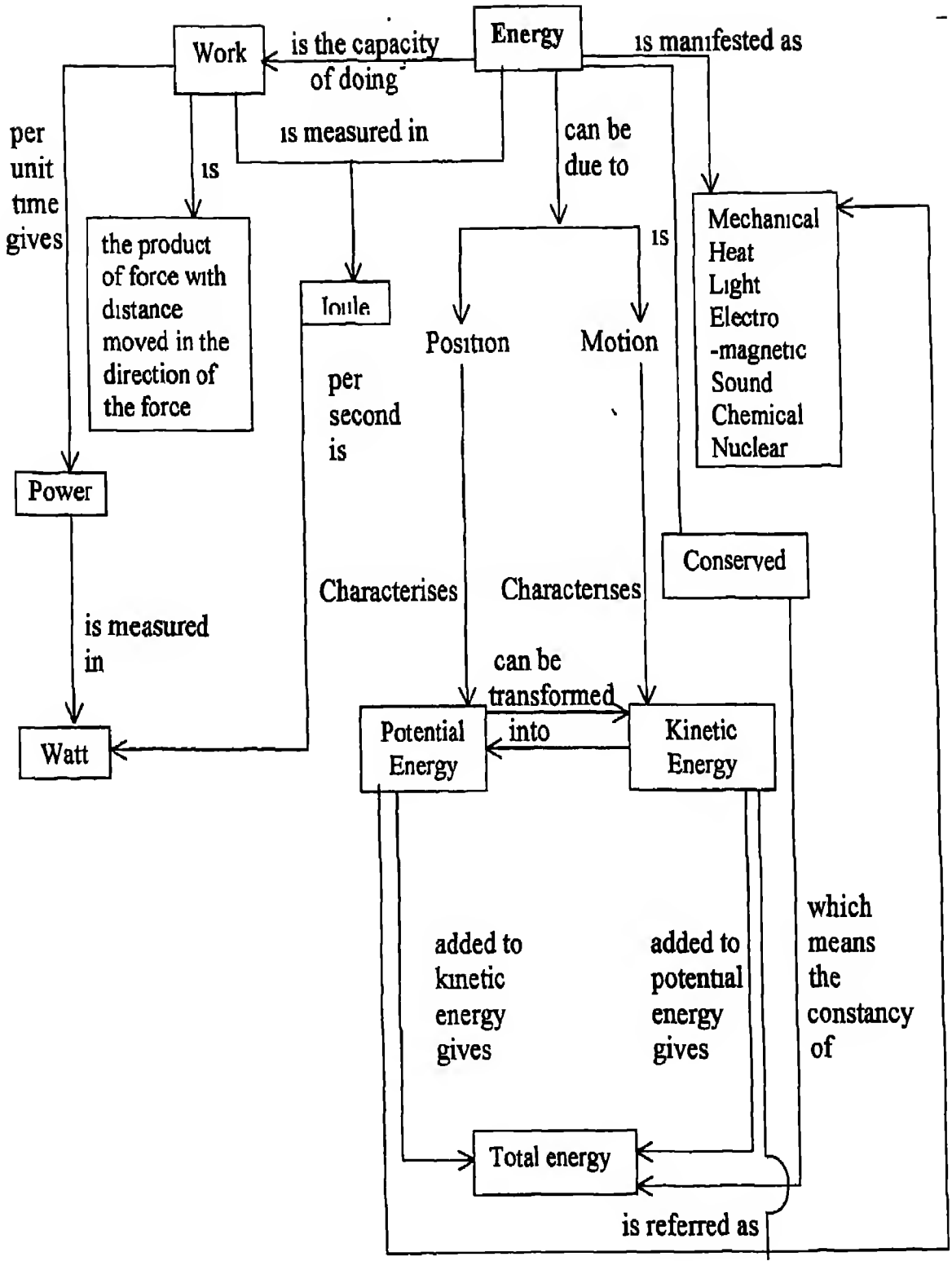
3. 2 mgh

4 Kinetic energy is lost in the form of sound energy, light energy, heat energy etc

5. See the text.

6. Conventional: Coal, oil, Natural gas, Wood, Water-hydro Power, Non-conventional: Wind, Water-Energy from oceans, Geothermal, Nuclear, Bio-energy, Solar energy.

7. Energy consumption is increasing while conventional sources of energy are getting exhausted. Alternate sources of energy are to be harnessed and judicious use of energy is to be made.


Work
is the capacity of doing
Energy
is manifested as
per unit time gives
is
is measured in
can be due to
Mechanical
Heat
Light
Electro -magnetic
Sound
Chemical
Nuclear
the product of force with distance moved in the direction of the force
Joule
is
Position
Motion
per second is
Power
Conserved
Characterises
Characterises
is measured in
can be transformed into
Potential Energy
Kinetic Energy
Watt
added to kinetic energy gives
added to potential energy gives
which means the constancy of
Total energy
is referred as

Our Environment

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Reader in Zoology

Overview

Environment means surroundings. Our environment provides us food to eat, air to breathe, water to drink, light for vision and suitable temperature to live. The physical components of environment are soil, water, air, light and temperature These are termed as **abiotic components** Living things in the environment such as plants and animals including human beings are collectively referred to as **biotic component**. Living organisms do not live in isolation. They interact with one another and also interact with the non-living surroundings in which they live. The environment together with the existing living organisms in it constitute **Biosphere.**

Objectives

After studying this unit, teachers will be able to

i) identify the living and nonliving things in their surroundings;

ii) differentiate between the living and nonliving things;

iii) identify their social environment and list the components of social environment;

iv) define habitat and different types of habitat of organisms;

v) define adaptation and significance of adaptation;

vi) know various adaptive features of organisms for different modes of life;

vii) recognize and explain the interdependence of living, nonliving and social environment;

viii) define and identify the components of an ecosystem;

ix) develop an ecosystem as a project;

x) describe the elements of a food chain and a food web;

xi) illustrate some food chains and food webs from their surroundings,

xii) understand the concept of biosphere;

xiii) understand the importance of sunlight and temperature for sustenance of life,

xiv) describe how the various sources of energy on earth can be traced back to solar energy;

xv) trace the cycle of essential elements from their reservoir through the food chains and food webs and back;

xvi) illustrate the natural cycles such as water cycle, carbon cycle, nitrogen cycle and oxygen cycle;

xvii) understand how man's activities have disrupted the different biogeochemical cycles,

xviii) understand the ethical and scientific reasons for protecting the environment,

xix) develop values and attitudes required to live in harmony with the environment and

xx) relate technology, society and environmental issues

Concepts and Transactional Strategies

At primary level, children were provided with experiences to help their socio-emotional and cultural development with a realistic awareness and perception of the phenomena occurring in the environment. They can also recognize plants and animals in their surroundings. Ensuring participation of all children in the activities, which will help in elaborating the concept of environment further, will further strengthen the experiences gained earlier. Variety of charts, models and fun games can be used for teaching this unit. Discussions, project work, and films can help students to understand the concept better. Students must be provided with problem solving situations related to their social context. The following concepts related with environment have been discussed.

- Physical environment
- Living environment

- Social environment
- Physical, living and social environment interact with each other
- Habitat
- Adaptation
- Biosphere
- Ecosystem
- Food chain, food webs
- Biodiversity
- Conservation of biodiversity
- Biogeochemical cycles – Carbon cycle, Oxygen cycle, Nitrogen cycle and water cycle.
- Air Pollution
- Water pollution
- Land pollution
- Soil erosion

A. Physical, living and social environment

To enable your student to understand this subunit, you must help them to understand the concepts (1 to 5).

Concept 1. There are numerous living things in our surroundings which constitute our living environment.

Transactional Strategy

Students can be helped to develop this concept by doing activities such as:

Activity 1

Students may be asked to prepare a list of living of things around them and also to indicate where these are found in a tabular form.

Living things	Found in
Banana tree	Soil
Grains	Soil
Lotus	Water
Earth-worm	Soil
Ants	Soil
Termites	Wood
Fish	Water
Frog	Land, Water
Snake	Soil
Lizards	Trees
Birds	Trees
Dog	Land
Algae	Water
Snail	Water, Land

Each student will have a different list. Students should be encouraged to compare and discuss their responses.

Activity 2

Students may be asked to observe various animals and record various facts about them, such as how they move, whether they move during day time or night time, what they eat etc. in a tabular form.

Animals	Moves with the help of	Moves during	Eat
Owl	Wings	Night	Fruits
Parrot	Wings	Day	Fruits
Earthworm	Body wall	Night	Soil
Frog	Limbs	Day	Insects
Cat	Legs	Day, Night	Milk, Fish
Fish	Fins	Day	Plankton
Bat	Wings	Night	Fruits

On the basis of their record of observations the students may be helped to conclude that all animals move around, eat, grow and reproduce

Concept 2. There are numerous nonliving things in our surroundings, which constitute our physical environment.

Transactional Strategy.

Students can be helped to understand the concept of physical environment with the help of following activity.

Activity 3

Students may be asked to prepare a list of nonliving things in their surroundings and also to indicate which of these are natural and which are man made and whether they grow by themselves in the following manner.

Non-living things	Natural/Man made	Grows
Table		
Water		
Air		
Stone		
Books		

On the basis of their observation, students should be able to differentiate living from non-living environment.

Concept 3. Materials such as paper, cotton and wood, which can be decomposed by bacteria/living organisms, are called biodegradable whereas synthetic materials such as plastics are non-biodegradable.

Transactional Strategy

Students may be asked to list materials/objects, which they use in every day life. Student's responses may include: paper, plastic scale, wooden scale, cotton, polythene bag, shoes etc.

Which of these materials get spoiled by bacteria with time? To answer this question, students can do the following activity.

Activity 4

Dig up soil 10 to 15 cm deep at few spots in your school garden to make pits Now place the articles listed above one in each pit Cover with soil. After two to three months again dig the soil and take out these materials. Students will observe that wood, cotton, paper and leather have

been decomposed by bacteria/micro-organisms where as plastic bottles and polythene bags are not decomposed.

On the basis of their observations, students may be helped to infer that some materials are biodegradable whereas synthetic materials such as plastics and polythene bags are non-biodegradable. These non-biodegradable plastics and polythenes cause serious environmental hazards. Sometimes they block water pipes and choke sewerage system. Students may be encouraged to use paper/cotton bags in place of polythene bags.

Concept 4. We live in a society that has structure and dynamics and this constitutes our social environment.

Transactional Strategy

The concept of 'social environment can be explained by taking school, family, village, city etc. you can ask students to describe their school environment. They may describe school environment in terms of friends, teachers, trees, playground, studies, exams and discipline. In school, students acquire knowledge, make friends, play, learn to respect teachers, become disciplined, acquire values of punctuality etc.

That means school influences students' life in many ways. You can ask students to compare the rural and urban environment. Students may describe the influence of urbanization and industrialization on their lives. Social institutions and systems have provided us policies, rules, network and other facilities for better living. For example, you observe rules while crossing a road. There are rules to check vehicular pollution. The people, the social system, its institutions and dynamics all constitute our social environment.

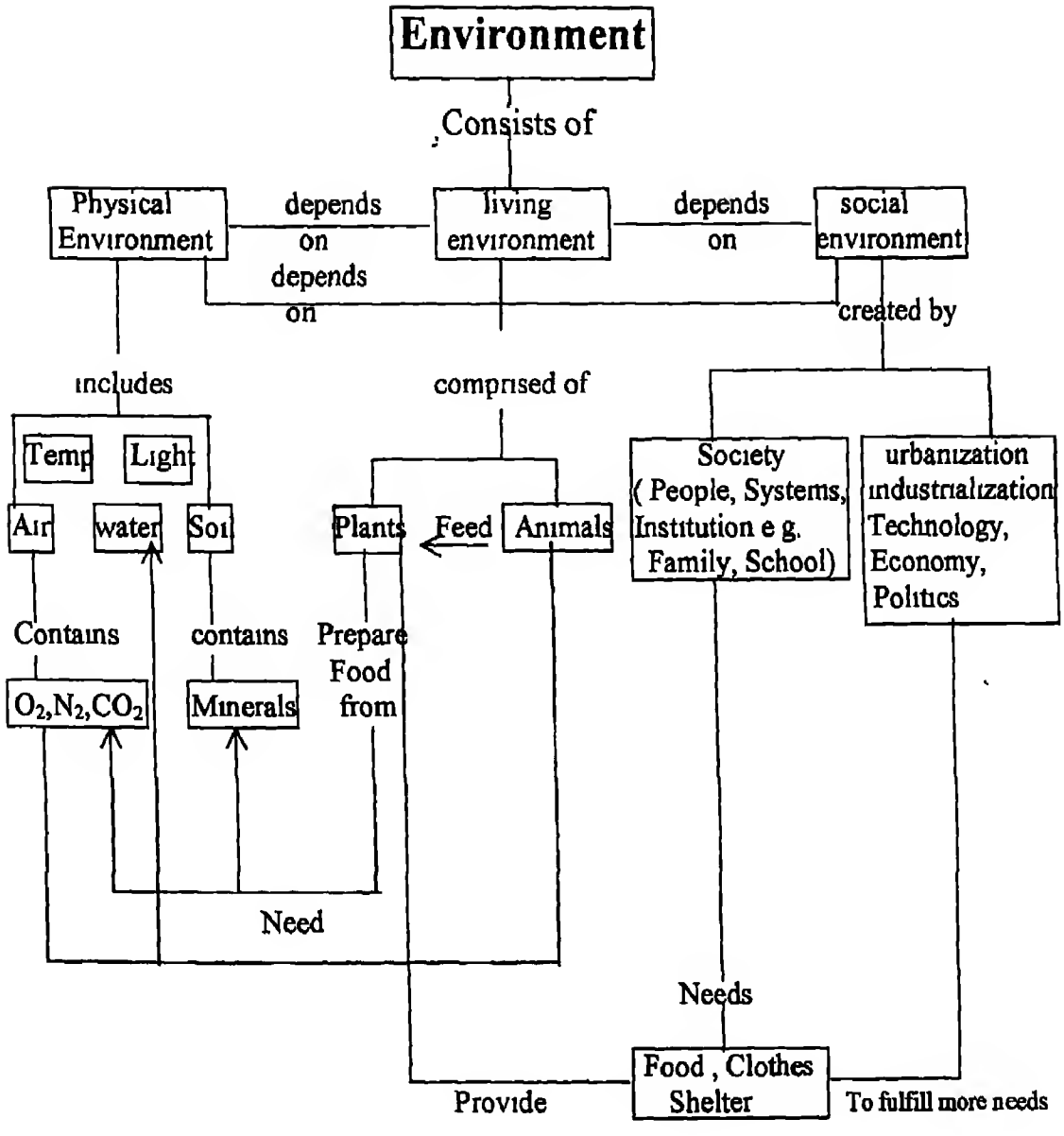
Concept 5. Physical, living and social environment interact and are interdependent on each other.

Transactional Strategy.

You can help your students to understand this concept using a concept map Students may work out many more linkages, which would enable them to understand the concept.

Activity 5

Draw a concept map on the black board with the help of student's responses. Write the most general concept at the top followed by sub-concepts Then draw vertical and horizontal linkages between different concepts. You may get a concept map as shown below.



[Concept Map – Environment and its components]

B. Habitat and Adaptation

Concept 6: The habitat of an organism is the place where it lives and grows

Transactional Strategy

Students can be helped to develop this concept by doing activities such as:

Activity 6

Students may be asked to visit local habitat like school garden, pond etc. and prepare a list of all plants and animals observed Record the observations as follows:

a) Observe all plants found in water/Land
b) Observe all animals found in water/Land.
c) Observe basic differences between aquatic and terrestrial organisms.

Activity 7

Students may be asked to observe the local habitat of their neighborhood and prepare a list of all organisms that are seen. Record the observations in a tabular form mentioned below:

Organisms seen	**Habitat Aquatic/terrestrial/aerial/ Arboreal/amphibious**	**Plants/animal**
Butterfly		
Parrot		
Lotus		
Owl		
Monkeys		
Camels		
Jasmine		

On the basis of their observations, students should be able to conclude that different organisms grow in different habitat.

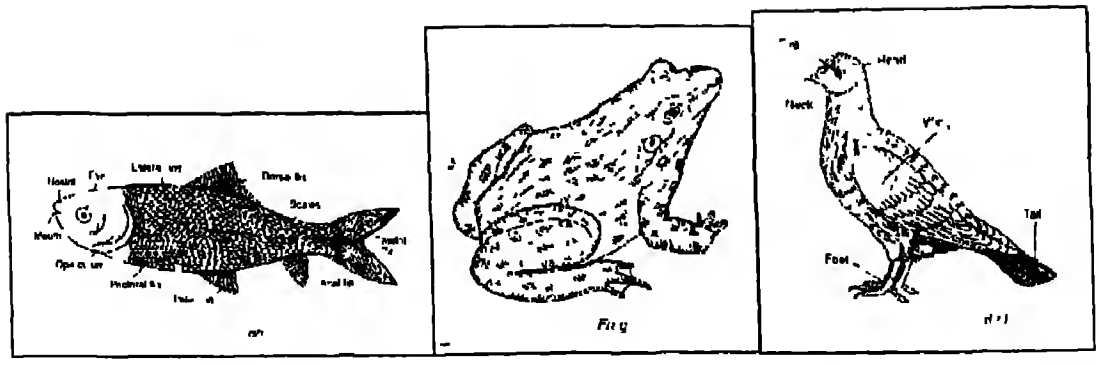
Concept 7: Various structural and functional adaptive features enable organisms to survive successfully in their respective habitat.

Transactional Strategy

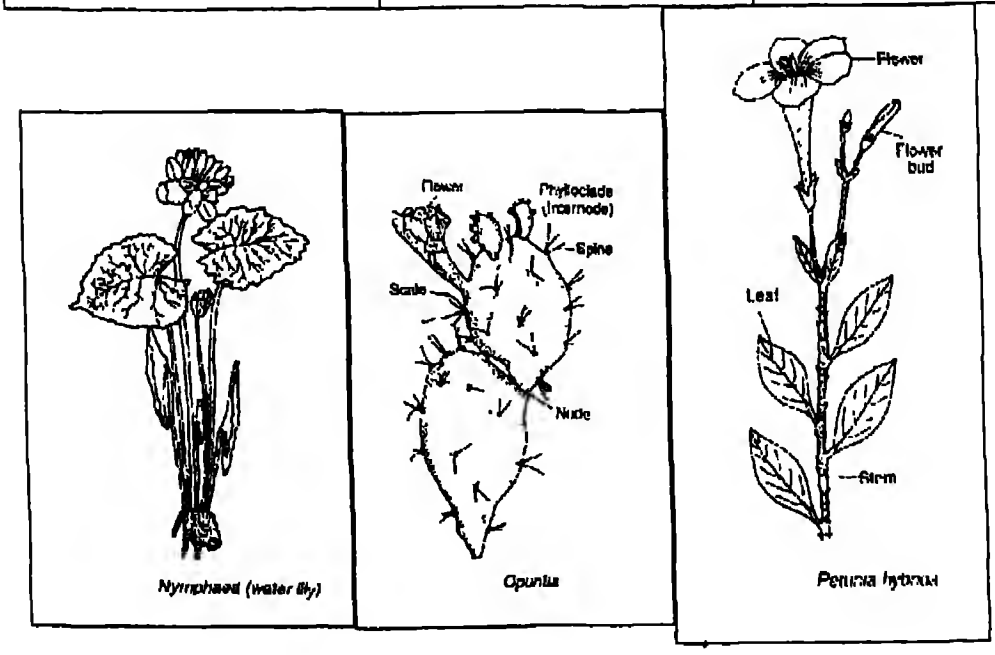
The students can be helped to understand the concept of adaptation by taking illustrations from their surroundings.

Activity 8

Students may be asked to compare external features in the organisms of different habitat and note down various modifications shown by them.



Name of animal	Type of habitat	Adaptive characters
Mole	Fossorial	Tapering head, clawed digits help in burrowing
Fish	Aquatic	Body compressed laterally and presence of fins, help in swimming, gills help in respiration.
Bats	Aerial (Volant)	Forelimbs are modified into wings for flying, bones with air cavities to make body light.
Frog	Amphibious	Webbed feet for swimming, bulging eyes compensate for absence of neck, soft skin.



Name of plants	Type of habitat	Adaptive characters
Opuntia	Xerophytic	Leaves are modified into spines which help to reduce the loss of water, stems are succulent and green which carryout photosynthesis.
Tomato	Mesophytic	Solid stem and freely branched, leaves variously shaped, generally thin and large.
Water lily	Hydrophytic	Floating leaves with long petioles with poorly developed root system.

On the basis of their observations the students may be helped to conclude that living things develop morphological and physiological changes over long period of time to increase its chances of survival and continuation of race.

C. Ecosystem and its Components

Concept 8: Interaction between living organisms (biotic component)and other non-living abiotic component of biosphere constitute the ecosystem.

Transactional strategy

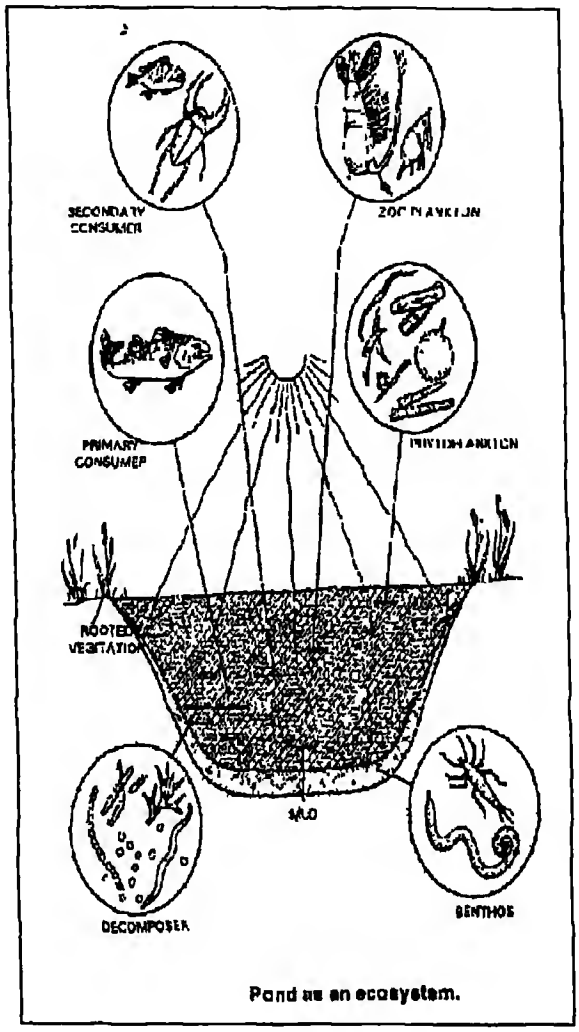
The concept of ecosystem can be explained to students by asking them to visit a pond or a lake or taking them for a picnic to a forest.

Activity 9

Accompany students to a nearby pond or lake. Ask students to note down various living and nonliving components they observe.

Nonliving	Living
Soil, water and sun light falling on water surface	Algae, small insects, snails, crabs, small fishes, big fishes, snakes, frog, floating plants, rooted plants

The students may be asked to draw a diagram of pond showing above components and find out their relationship with each other



Pond as an ecosystem.

From these illustrations, students may infer that an ecosystem contains living and nonliving components. The living component has a set of interacting species. The nonliving components include rocks/soil, water, air, sunlight and temperature. The students may be helped to understand the importance of plants (producers) in an ecosystem and how they convert solar energy into chemical energy during photosynthesis.

Concept 9: The sequence of who eats whom in an ecosystem is called a food chain. All ecosystems have complex feeding networks, made up of many different food chains. This feeding network is called a food web.

Transactional strategy

The concept of food chain can be introduced by asking students questions based on their observations such as:

Fill in the blanks:

a) _____Contains chlorophyll, which helps to trap solar energy and convert it into chemical energy.
i) Algae ii) Grass iii) Trees iv) All green plants.

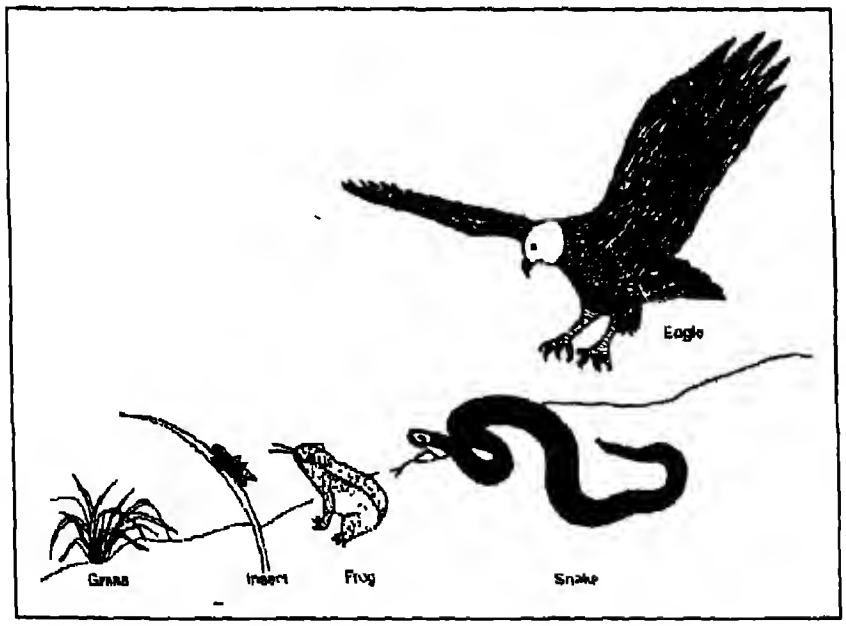
b) Green plants synthesize carbohydrates during photosynthesis and are called _____
i) consumers ii) producers iii) herbivores iv) decomposers.

c) _____ eat grasses and are called herbivores.
i) Rabbit ii) Dear iii) Insects iv) All of these.

d) Frogs eat _____and are called primary carnivores.
i) grasses ii) fishes iii) insects

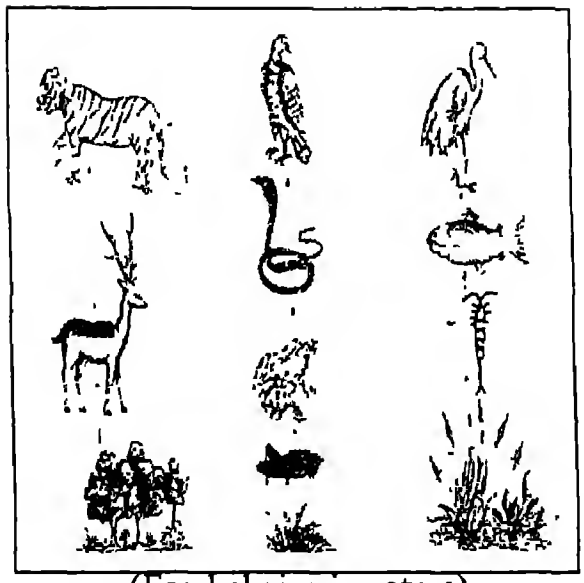
e) _____eat frogs and are called secondary carnivores.
i) Snakes ii) Dear iii) Goat

Students can be asked to draw linkages between (a), (b), (c), (d) and (e)



(A five step food chain in a grass land ecosystem)

Now students may be asked to prepare number of food chains of different habitat, such as aquatic, grass land, Forest, desert etc.

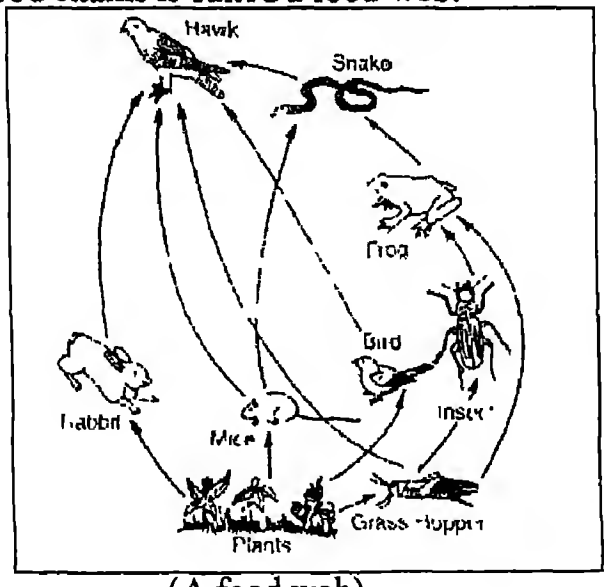


(Food chains in nature)

On the basis of students responses they may be helped to conclude that directly or indirectly all organisms depend on plants for their food Animals that eat plants are called herbivores Animals that eat herbivores are called carnivores Higher carnivores eat lower carnivores These way food linkages are formed between plants, herbivores and carnivores These food linkages are called food chains. Since plants prepare their own food, they are called **autotrophs.** Animals depend on plants and other animals for their food and are called **heterotrophs.**

Activity 10

Ask students to draw number of food chains of a particular habitat and then interlink them according to feeding habit. This network of interconnected food chains is called a **food web.**



(A food web)

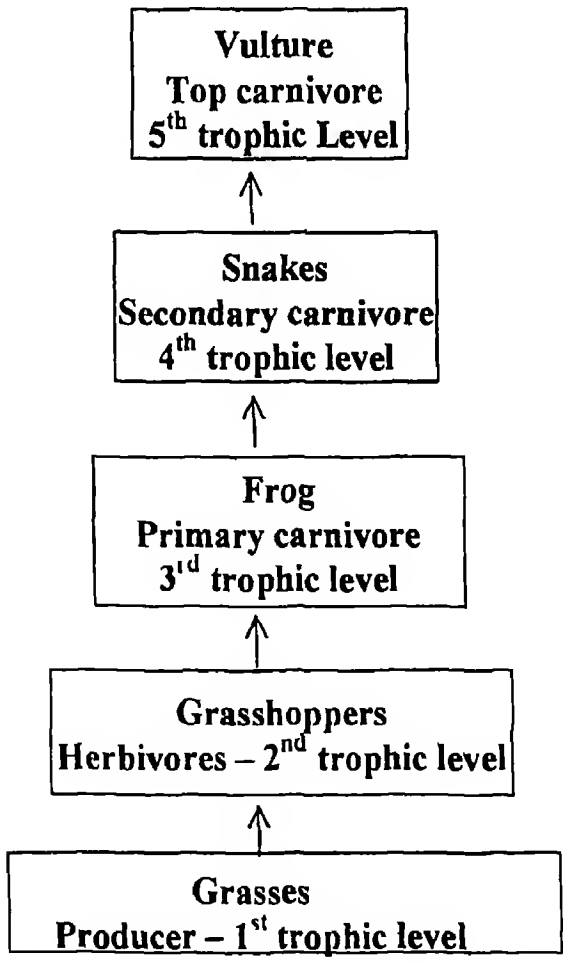
From the above illustration, students will be able to understand that in a food web, each organism occupies a specific position, whether it is a producer, a herbivore or a carnivore One organism may occupy positions in more than one food chain, for an organism can obtain its food from different sources and in turn may be eaten by different types of organisms

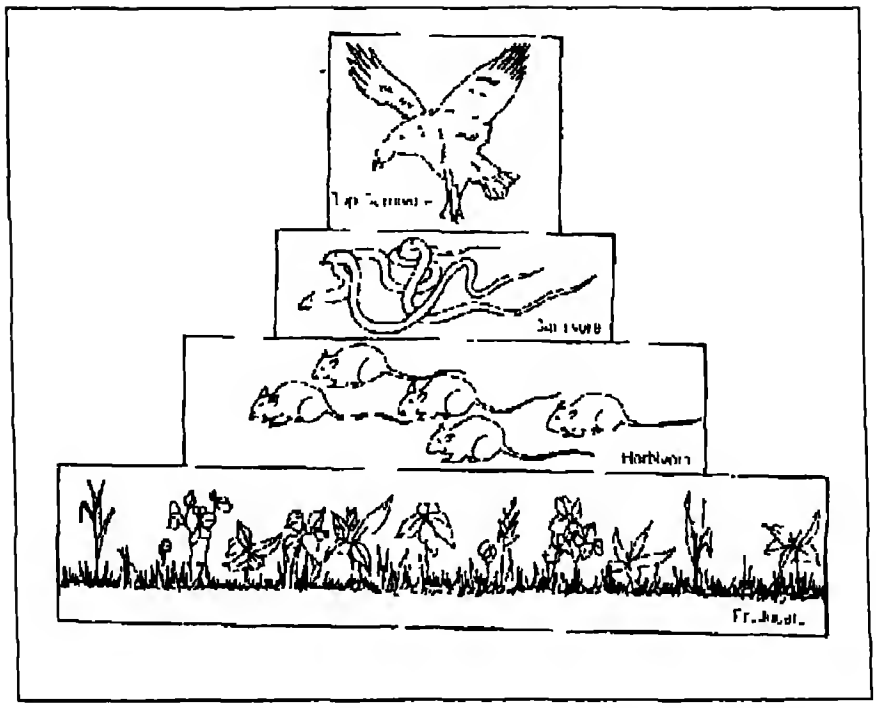
Students would also understand food relationship and interaction among various organisms in an ecosystem The mechanism of transfer of food energy and nutrients through various components of nature also can be understood

Concept 10: The various Levels or steps in a food chain at which the transfer of food (or energy) takes place from one organism to another are called trophic Levels

Transactional strategy

The concept of trophic levels and transfer of energy can be explained to students by asking them to analyse food chains they have studied.





Pyramid of numbers in a grassland showing trophic structure

The students may be explained, the green plants, which are autotrophs called producers, form the first trophic level The herbivores or primary consumers forms the second trophic level The animals that feed upon herbivores (primary carnivores) constitute the third trophic level Top carnivores which feed upon primary carnivores form the fourth trophic level and so on.

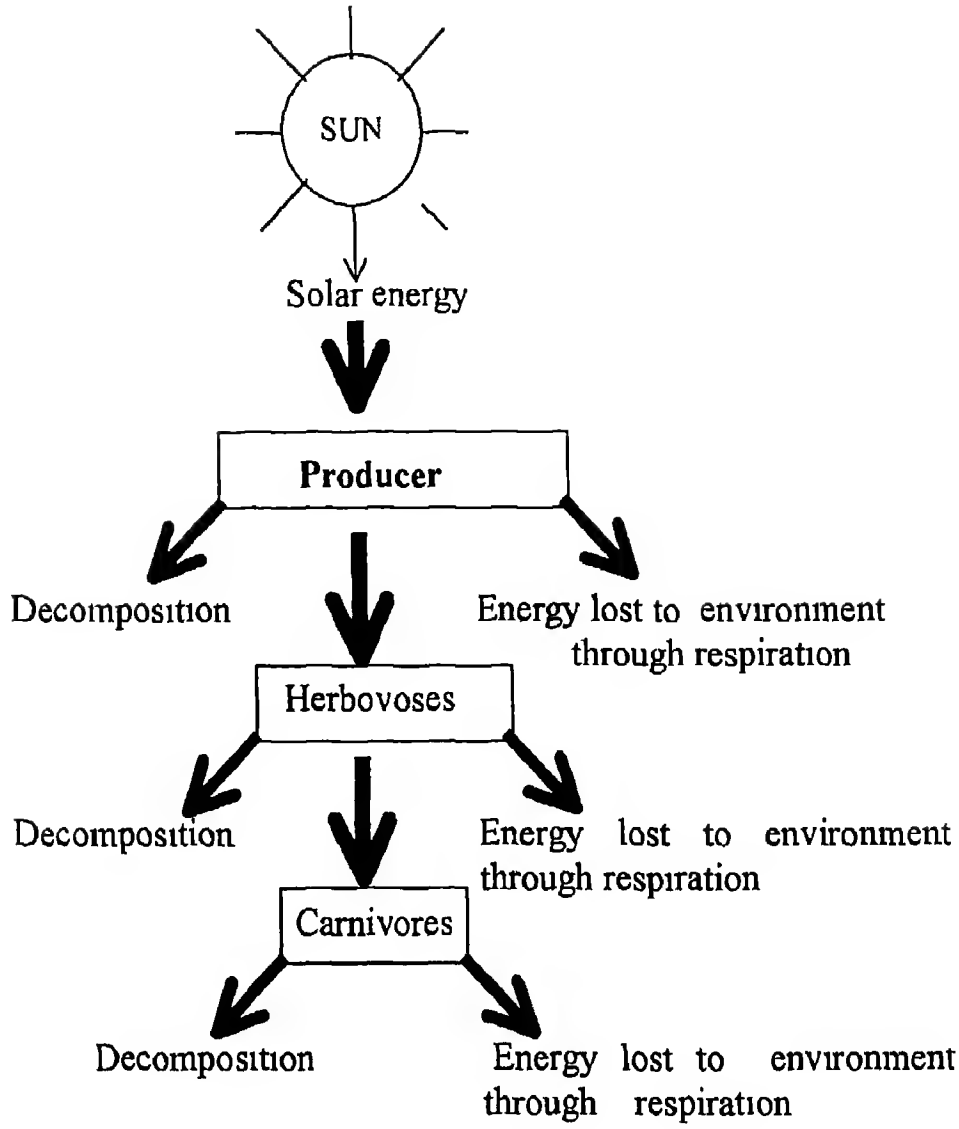
Energy flow in Ecosystem:

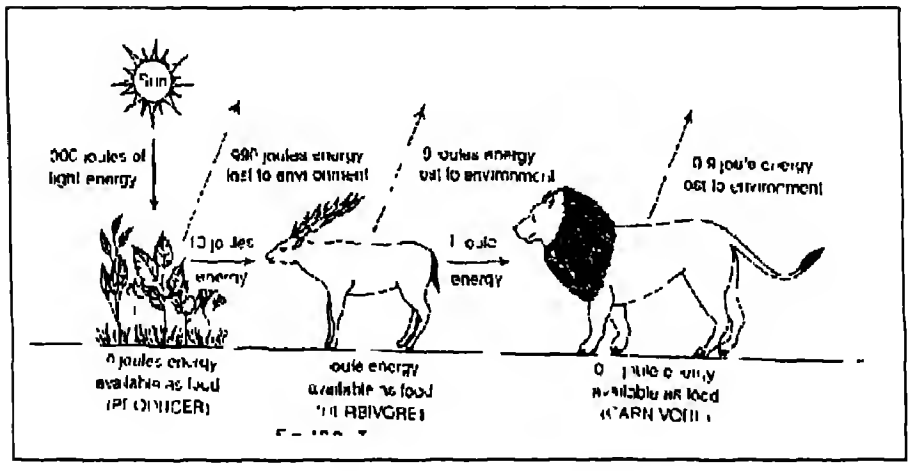
Concept 11: Energy flows from sun, through producers to consumers in a single direction only

Concept 12: There is a loss of energy as heat at each trophic level, the amount of energy available at each successive level goes on decreasing. The energy available is maximum at the producer level.

Transactional strategy

You can help students to understand the concepts related to energy flow in food chain through discussion and debate.





(Energy flow in ecosystem—10% law in a food chain)

Students have learned in the earlier sections that plants prepare their own food using solar energy, air and water Plants produce food for

herbivores and are therefore producers while herbivores in this case are consumers. When carnivores get their food from herbivores, carnivores become secondary consumers

Students may be explained that out of the enormous amount of solar energy only a very small fraction is transformed by plants into chemical energy (carbohydrates) by the process of photosynthesis You may further ask what happens to this energy in producers (plants). The probable answer would be for growth You may explain to them that energy is utilised by plants for their metabolic activities Only a small part of energy is used up in respiration and for growth while a major portion of the energy is not utilised and is released to environment as heat When herbivores consume the producers, chemical energy stored in plants is transferred (with food) to them In herbivores, some energy is transformed to heat which is lost to the atmosphere, some energy is utilized in respiration and some is stored in tissues Here students may be informed that about 90% of the energy is used up at each trophic level and only 10% of it is transferred to the next trophic level.

On the basis of this discussion, the students may be helped to conclude that there is maximum energy at the producer level and as you go further and further the energy in food goes on decreasing at each trophic level

D. Biogeochemical cycles

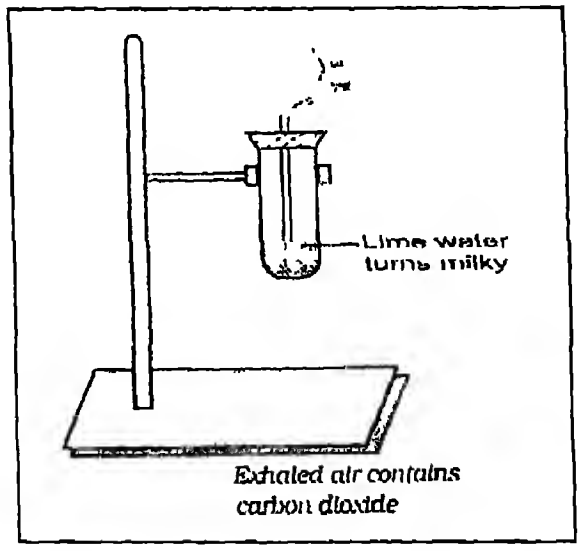
Concept 13: Nitrogen, Oxygen and carbon dioxide of air circulate in nature through biochemical cycles called nitrogen cycle, Oxygen cycle and carbon cycle

Concept 14: Oxygen cycle is the circulation of Oxygen in and out of living things.

Concept 15: Carbon cycle is the circulation of carbon from the environment into the living things and then back to environment.

Transactional Strategy

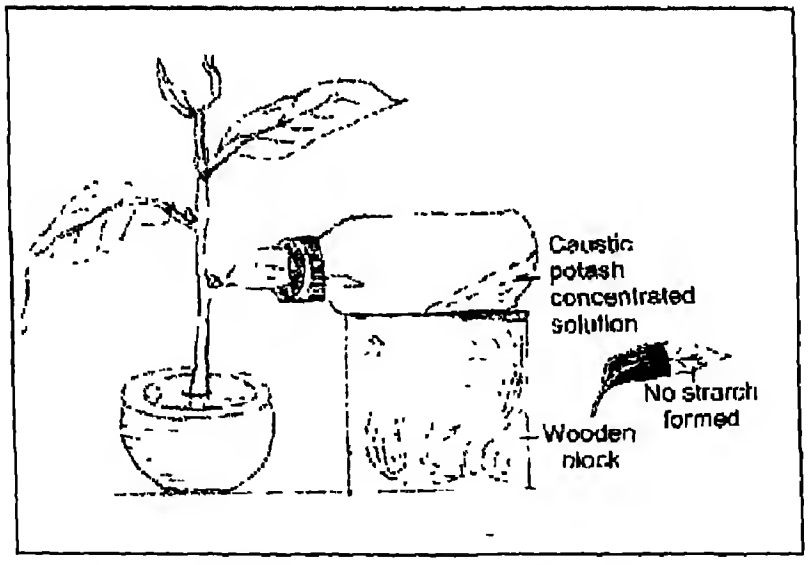
The Oxygen cycle and carbon cycle can be discussed simultaneously. Students may conduct activities as illustrated here to understand which constituents of air are used by plants and animals



(Exhaled air contains carbon dioxide)

Activity 11

Take limewater in a test tube. Fit in a delivery tube through a cork as shown in figure above. Now blow out air from mouth into the limewater. What do students observe? The limewater turns milky Students may infer that we breathe out carbon dioxide



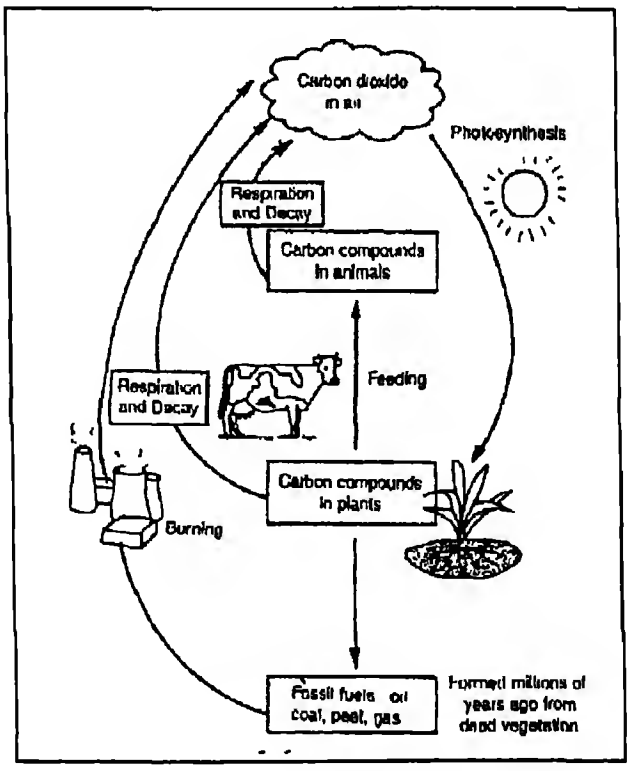
(CO_2 is required for preparation of food by plants)

Activity 12

Keep a potted plant in a dark room for two/three days When the plant is still in dark, insert one leaf of this plant between the halves of the stopper without plucking the leaf from the plant A part of leaf should be out of the cork on both sides as shown in above figure. Take 10 ml of caustic potash solution into a small reagent bottle and close the mouth with the stopper having the leaf in its centre. Now keep it in the sunlight for a day or two. Then remove the leaf from the stopper and pluck it from the plant Put iodine solution over both halves of leaf. Students will observe that the portion of leaf, which was kept inside the cork, did not change its colour Students may conclude from the observations that –

a) Leaves prepared no food when plant was placed in dark
b) Part of leaf getting carbon dioxide prepared food but part of leaf not getting carbon dioxide could not prepare food, when placed in sunlight.

You may further explain the process of carbon cycle with the help of a chart as shown below.



(Carbon cycle in nature)

Respiration can be represented as food (carbohydrate) + Oxygen → Carbon dioxide + water + Energy.

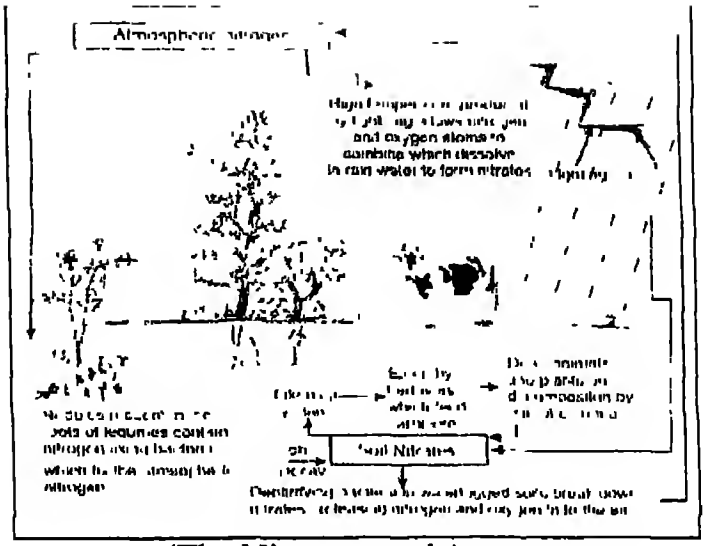
Preparation of food by plants (photosynthesis) can be represented as Carbon dioxide + water + Energy → Food (carbohydrate) + Oxygen.

Animals and plants use the oxygen given out by plants during photosynthesis during respiration. Plants use the carbon dioxide exhaled by animals during respiration. In a balanced ecosystem. Photosynthesis and respiration will keep the oxygen and carbon dioxide levels in the atmosphere steady. In reality, this is not as simple. The burning of fuels to run vehicles, industries and other commercial and domestic purposes give off large quantities of carbon dioxide, which mix up in the air. Also burning of fuels consumes a large quantity of oxygen from atmosphere. Cutting of trees and deforestation curbs the supply of oxygen to the atmosphere.

Concept 16: The circulation of nitrogen compounds in the environment is called the nitrogen cycle.

Transactional Strategy

The concept of nitrogen cycle can be explained with the help of a chart as shown below. All living organisms-plants and animals need nitrogen because it is necessary for protein formation including DNA. However, organisms cannot use nitrogen directly Animals require oxygen in an organic compound. Plants including algae and bacteria can take up nitrogen either as the nitrate ion (NO_3) or the ammonium ion (NH_4^+). The atmospheric nitrogen gets converted to nitrate or ammonium ion by plants or by lightning. Lightning produces high temperatures which allow nitrogen and oxygen atoms to combine. These oxides of nitrogen dissolve in rainwater to form nitrates. Nitrogen fixing bacteria in humus and in root nodules of leguminous plants e.g. peas; beans etc. convert atmospheric nitrogen to nitrates The soil nitrates are taken by plant roots. Plants are eaten by herbivores and herbivores by carnivores. The dead plants and animals and droppings (urine and faeces) decomposed by fungi and bacteria release nitrates into the soil. When bacteria in waterlogged soil denitrify soil nitrates, nitrogen and oxygen are released into the atmosphere. Students may also appreciate the importance of growing leguminous plants for nitrogen fixation and the role of decomposers in nitrogen fixation

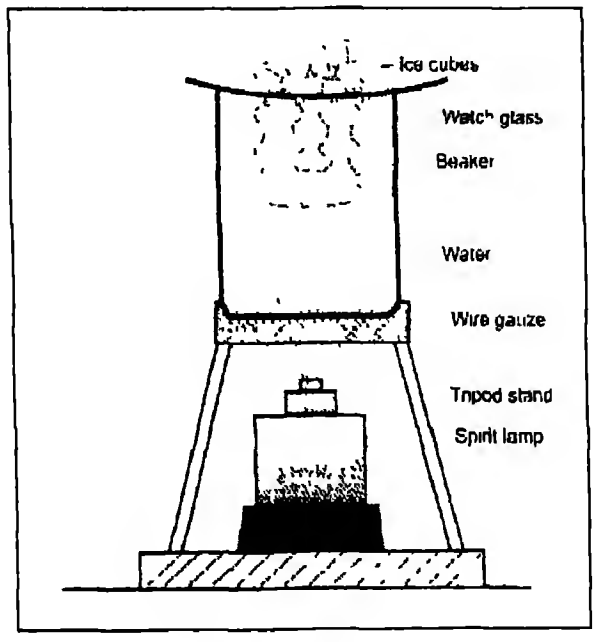


(The Nitrogen cycle)

Concept 17: The water cycle is a ceaseless process of water circulation from ocean, river, pond, lake, soil, plants and animals to air and from air back to ocean, river, pond, lake and soil.

Transactional Strategy

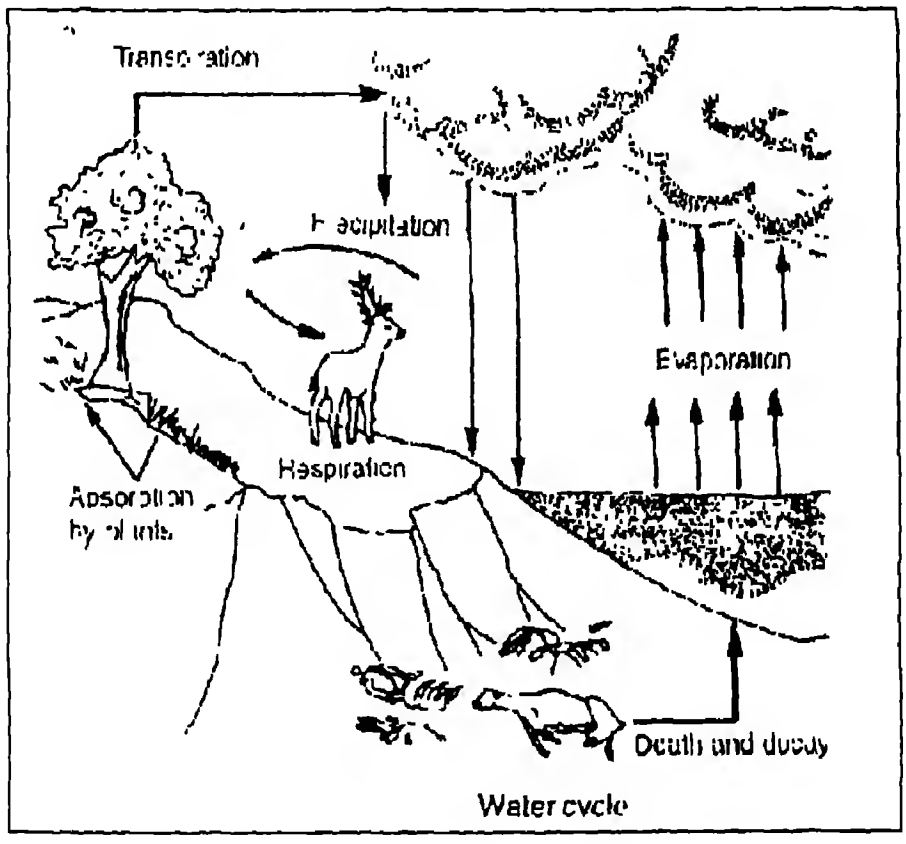
To help students to understand the cyclic process of transfer of water from atmosphere to land to oceans and back to atmosphere You can design activities as illustrated here.



(The Rain formation)

Activity 13

Fill one-third of the beaker with water Place a watch glass containing some ice cubes to cover the beaker Now heat water in beaker Students will observe water vapours rising from water surface in beaker. When water vapours strike the watch glass. These condense to form water droplets, which fall back in the beaker You can further explain to the students that in the same way, water evaporates from the surface of oceans, rivers, ponds, lakes, soil and vegetation Sun warms up the air near the surface of the earth. This warm air containing water vapour rises up. At higher altitudes atmospheric temperature is low When water vapour cools at higher altitudes, minute water droplets are formed which fall back on earth as rain. You can illustrate water cycle with the help of a chart as shown below



(The Water cycle)

E. Pollution

Concept 18: Water pollution refers to the degradation of water quality due to physical, chemical or biological substances (called pollutants).

Transactional Strategy

You may make students existing concepts explicit by asking questions such as why river water taken directly from river is not fit for drinking Why we should not throw garbage or dead organisms into rivers/ponds? What harm can industrial wastes do if thrown into a river? You will obtain a variety of answers from students Let students discuss their ideas and finally you can conclude the discussion as illustrated in the table:

S. No.	Pollutants	Source	Effects
1	Dead organic matter	Dead animals & plants· raw sewage & agricultural wastes thrown in rivers	Diseases such as cholera
2.	Pathogens	Human and animal excreta	Water born diseases such a cholera
3	Inorganic chemicals (P, N, mercury, acids and so on).	Phosphorus & nitrogen from agricultural land (fertilizers) and heavy metals from industrial wastes	Damage ecosystem and cause human health problems
4.	Organic chemicals her-bicides Dye industrial waste Hospital and pharmaceutical wastes	Agricultural use of pesticides	Ecological damage and human health problems
5	Radioactivity	Nuclear power industry, minerals & natural resources	Health problems

Concept 19: Air pollution refers to the addition of such substances to the air and in concentrations sufficient to cause harmful effects to health, crop or property.

Transactional Strategy

Students must have experienced that burning of fuel wood , garbage, coal and diesel produces smoke which mixes up with the air While traveling by road, the smoke emitted from vehicles causes irritation in eyes and respiratory problems. They might have also experienced that burning of crackers on Diwali produces smoke, which causes suffocation and irritation in eyes. Based on student's experiences, you may ask them to list the sources of air pollution and the pollutants emitted from these sources. With the help of pupil participation, you may draw a table on the black board as illustrated in table below·

Source of Pollution	Pollutants
Vehicular traffic	SO_2, NO_2, CO, SPM, Hydrocarbons
Industries	Lead, Aluminum, CO, SO_2, NO_2, CFC, SPM
Domestic	SO_2, NO_2, CFC, CO, SPM
Power plant	SO_2, NO_2, SPM

You may further discuss with them the harmful effects of these pollutants. Sulphur dioxide and nitrogen oxides cause respiratory problems and irritation in eyes Lead can damage kidneys and nervous system; suspended particulate matter (SPM) is also associated with respiratory problems Pollutants like benzene are carcinogenic, that is, it can cause cancer. Pollutants also harm vegetation Pollutants are responsible for phenomenon like acid rain, global warming and ozone depletion.

Concept 20: Acid rain is the phenomenon where some gases present in the atmosphere such as CO_2, NO_2 and SO_2 combine with water drops to form acids and make rain acidic.

Transactional Strategy

Students might have observed that metallic statues or decorative metal pieces on buildings even metallic name plates on their doors or show pieces in their houses get corroded and tarnished. Why does this happen? How do you clean if a copper coin or utensil turns green? Students have learnt that air contains carbon dioxide, sulphur dioxide and nitrogen oxide Automobiles and industries are the main source of these gases. Carbon dioxide dissolves in water to form a weak carbonic acid. Sulphur dioxide

forms sulphuric acid and nitrogen oxide forms nitric acid when dissolved in water Rain washed down these oxides and becomes acidic. You can illustrate this phenomenon with the help of a chart as shown earlier

Acid rain affects plants, soil, water and aquatic life It may be of interest for teachers to know how acid rain affects plants and soil Magnesium is an important constituent of chlorophyll. Acid directly damages the leaves, kills the microorganisms present in soil and is responsible for leaching of soil nutrients (leaching means dissolving in water and getting washed away) Acidic rain affects water and aquatic life Acidic water is harmful for fish and other aquatic animals. Acid rain falling on slopes dissolves metals like aluminum in the soil Some of these metals are toxic to organisms

Concept 21: Global warming refers to the increase in the average global temperature of the atmosphere near earth's surface.

Transactional Strategy

Students know that the main source of energy and temperature for earth is sun. You can explain the phenomenon of global warming using students prior knowledge. Sunlight that reached earth, warms the atmosphere and the surface of earth. Earth's atmosphere system then re-radiates heat as infrared radiation. Water vapour and several other gases, including carbon dioxide, methane and chlorofluoro carbons (CFCs) warm Earth's radiation They trap some of the heat energy radiating from Earth's atmosphere because they absorb and re-emit atmospheric system. The trapping of heat is somewhat analogous to green house effect and is called the **Green House Effect** Students can do the following activity to understand the concept of green house effect.

Activity 14

Take two wide mouthed glass containers of about 2 liters volume Cover one glass container with a glass plate and leave the other container open Place one thermometer in each of the containers Cover outside of containers with the newspaper Keep both the containers in hot sun for about three hours. Measure the temperature in both the containers Students may infer on the basis of their observations that

a) The container covered with glass plate has more temperature compared with the open container

b) Glass cover admits solar radiation but prevents all the heat waves from going out of the container by either reflecting them or absorbing them and reemitting a large portion back inwards

c) The glass cover prevents convection currents from mixing the cooler air outside with the warm air inside.

Gases which trap heat energy are calaled gren house gases The pollutants CO2, SO2, N2O, CFC, CH4, O3 are greenhouse gases and are responsible for global warming. The main source of these pollutants is burning of fuels and gases emitted from industries CFCs are produced in air conditioning and refrigeration work

Concept 22: Ozone depletion refers to the thinning of ozone layer in the stratosphere.

Transactional Strategy

This concept has been included in this module for enhancing teachers knowledge ozone (O3) is a triatomic form of oxygen, in which three atoms of oxygen are bonded. Approximately 90% of the ozone in the atmosphere is found in stratosphere about 25 kms above the earth. This ozone layer in the stratosphere is called **ozone shield** because it absorbs most ultraviolet radiation that is potentially damaging to life In the lower atmosphere, ozone is a pollutant produced by photochemical reactions involving sunlight, nitrogen oxide, hydrocarbons, and diatomic oxygen The ozone balance is illustrated in figure

Ozone concentration in the stratosphere has been decreasing Significant ozone depletion over the Antarctica has been reported and this is called **ozone hole** There is not an actual hole in the ozone shield where all the ozone is depleted, but rather a relative depletion in the concentration of ozone that occurs during the Antarctic spring.

One of the hypothesis is that ozone in the stratosphere is being depleted by the presence of chlorofluorocarbons (CFCs). The CFCs emitted in the lower atmosphere by human activities are stable ad non reactive at lower atmosphere. Because CFCs have a long residence in the lower atmosphere and because the lower atmosphere is fluid with abundant mixing, the CFCs move upward and enter the stratosphere. There, they may be destroyed by highly energetic solar ultraviolet radiation. This process releases chlorine, a highly reactive atom. The reactive chlorine released may then enter into reactions that deplete ozone in the stratosphere. Massive destruction of ozone was identified and reported at Antarctic first in 1985 Since then, Antarctic ozone hole. The amount of depletion has varied from about 15% to 80%. Under natural conditions, the highest concentration of ozone is found in the polar regions and the lowest near the equator.

Concept 23: Air pollution needs to be reduced.

Transactional Strategy

You can use charts and models as teaching aid for teaching how air pollution can be checked You may ask students to list the areas in their locality where air pollution is more and if they could suggest the ways to reduce pollution Elaborate your discussion starting from students responses and list the main points on black board For example, most students know that vehicular pollution due to burning of diesel and petrol is one of the main causes of air pollution. You can further tell them that we have rules and acts for automobile pollution check. It is necessary and mandatory to get your vehicles checked for emission of pollutants every three months Students might have also heard about lead free petrol and sulphur free diesel. These reduce air pollution and we should use clean fuel in our vehicles We also have rules and acts on polluting industries Polluting industries should not be located in residential areas. The recycling of wastes reduces pollution to some extent.

You can reduce harmful pollutants in the air For example, by using smokeless chulas for cooking. Do not smoke and also do not allow others to smoke and also do not allow others to smoke in public places. In some places like Delhi, Government has banned smoking in public places. Burning of garbage and materials like tyres produces harmful pollution and their use should be checked You may motivate students to become responsible citizens and observe the rules for pollution check

For assessing the progress of pupils learning You can assign them some project work, which they can do in groups For example preparing charts and models on Carbon cycle Nitrogen cycle and Air pollution. You may also ask them questions of the type

a) Explain that acid rain is an environmental problem
b) Explain the factors, which disturb the nitrogen cycle in nature.
c) Explain how respiration and photosynthesis balance the oxygen-carbon cycle in nature

Check your progress- III

You may check your progress by solving questions such as

i) What are the harmful effects of ultraviolet rays and how are these related to ozone depletion?

How deforestation and burning of trees disturbs the carbon-oxygen cycle?

Food Production & Management

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Lecturer in Botany

Overview

Food is one of the basic requirements of all living organisms Food may be classified into the following groups: (a) Heat or energy – producing food having high calorific values such as carbohydrates and fats, (b) Body-building food such as proteins (c) Protective food such as confectioneries, etc. the energy value of food is expressed in terms of calories. A calorie is the amount of heat needed to raise 1 kilogram of water through 1^0C. It may be noted that 1 gm. Of carbohydrate yields about 4 calories, and 1 gm of fat about 9 calories The daily requirement of a man of average weight, doing moderate work, is about 3,000 calories, which must be obtained from the food he eats. Average Indian diet, it may be noted, produces only about 1,620 calories It is evident that food plants must contain sufficiently high percentages of carbohydrates, proteins, and fats and oils together with vitamins and essential minerals All cereals and millets are rich in starch and contain vitamins A, B and C They belong to Gramineae and are cultivated as annual crops. Cereals constitute the main food-stuff of human beings all over the world. Major cereals are rice, wheat, and maize and major millets (small grained) are sorghum, ragi and pennisetum

For proper nutrition of the human body, however, a balanced diet consisting of cereals, vegetables, pulses, vegetable oils, sugar, fruits and also milk and milk products and according to habit and custom fish, meat & eggs, etc is indispensable Among the important food crops of India cereals occupy about 60% of the total cultivable area, pulses about 18% and oil-yielding plants about 8%. After many years of shortage, mainly due to heavy pressure of population increase, India has now attained self-sufficiency in food grains with an annual production of over 150 million tones on the basis of the steps taken in the following directions· improved method of cultivation, increased use of pesticides and fertilizers and use of some high-yielding varieties of crops.

In our country, about ten percent of the produced food get wasted due to improper post-harvest management practices. If producing more and more food grains is necessary, storing them properly is equally important. Proper storage management of food is essential because many of our crops are

To ensure adequate supply of foodstuffs for our consumption through-out the year, it is essential to store them properly It also ensures the availability of good quality seeds for cultivation in the next season The harvested food grains, vegetables, fruits undergo several internal changes during storage If proper storage methods are not followed, deterioration of food products takes place As a result, the nutritive value of food gets reduced Furthermore, food may become toxic and unfit for human consumption. Therefore, it becomes increasingly important to improve our management processes

Activity 1. STUDYING THE NATURE OF SEEDS

Aim

To discover the structure of seeds

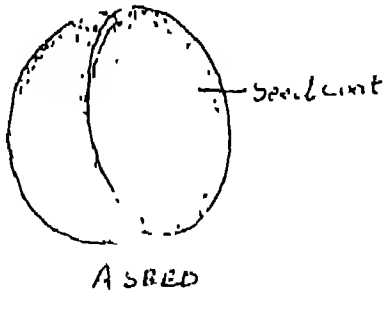
Concept to be developed: A seed consists of an embryo plant and stored food enclosed in a seed coat.

Requirements

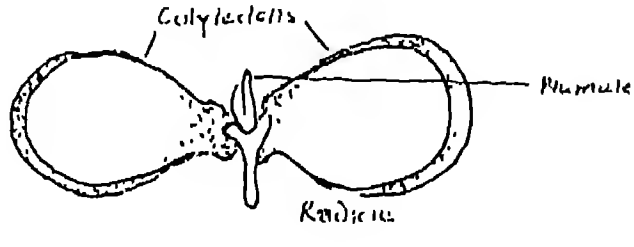
Lima bean seeds, forceps, scalpel, needle and dissecting microscope

Procedure

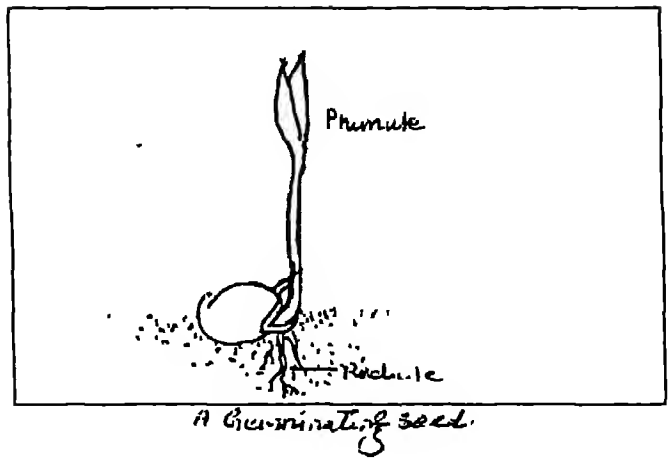
The night before you plan to use this activity, soak half of the lima bean seeds in water so that the seed covering will become soft Distribute dry Lima bean seeds to the Students and ask them to describe the seeds They should notice that the seeds are smooth, hard and dry. Then they should be able to find the place where each seed was attached to the plant Now, distribute the seeds that have been soaked overnight and ask the students to break the coatings of the seeds and open them. Ask the students to describe the parts of a seed Let the children describe the coat of the seed and suggest its function Ask the students to describe the contents of the seed and to suggest the function of the parts. They should notice that there is a tiny plant between two cotyledons The tiny plant develops into the adult plant and the cotyledons contain stored food



A SEED



STRUCTURE OF A SEED



A Germinating Seed.

Extending ideas

Suggest to the students that they make lists of seeds that we eat as food Help them develop the idea that we eat the food produced by the plant for the development of the plant embryo Have the students make a collection of the many different kinds of seed that we use as food

Test of learning

Q 1. Name the component of a seed that stores maximum food?

Q 2 Why do seeds split & coating gets removed upon soaking them in water?

Q 3. What is the role of seed coat?

Activity 2

SEED GERMINATION FOR RAISING CROPS

AIM

To demonstrate that water and air are essential for germination of seeds

Concept to be developed Seeds need both water and air for germination

Requirements

Sunflower seeds, potting soils and glass jar

Procedure

Ask the students to suggest ideas as to how the sunflower seeds could be made to develop into plants Suggest that they plant seeds under three different conditions in 3-glass jars Each glass jar should contain about

¼ of it potting soil so that the seeds between the inside of the jar and the potting soil so that the seeds are about ½ inch from the surface of the soil. Ask the students to label each glass jar with a number Have the students place all three jars in a warm location. The seeds in jar 1 would not be watered The seeds in jar 2 would be given water just to keep the soil moist The seeds in jar - 3 should be watered until water appears above the surface of the soil. Jars 2 and 3 should be watered to maintain the conditions described Let the students observe the jars each day and keep records of seed-growth After week, discuss the results the students recorded in their notebook

The seeds in jar-1 should not have sprouted at all because seeds in this jar received air but not water The seeds in jar-3 also should not have sprouted and may even have begun to rot The seeds in jar 2 should have sprouted only It happened so because seeds require both air and moisture, but moisture without air is not sufficient for the germination The seeds in jar 3 were always completely covered with water and, therefore, received no air.

Extending ideas. in the germination of seeds, the embryo plant uses both air and water to grow The students may continue to record the development of the plant They should notice that as each plant grows, the cotyledons become smaller as the stored food is used up eventually, they drop off entirely when a plant has produced additional leaves and is able to make its own food The students may draw the growing plants beginning with the seed until the cotyledons drop off They should record the date of each drawing

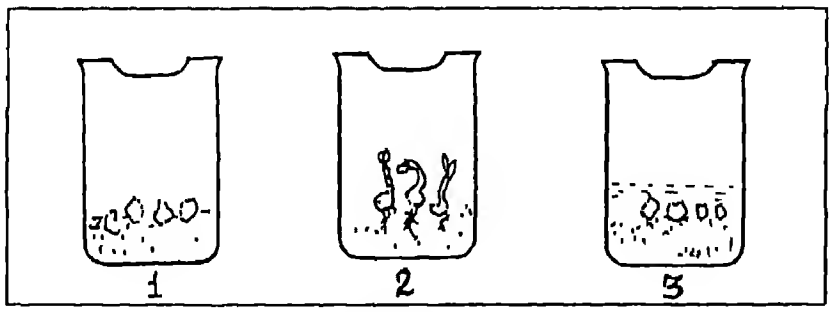


Illustration – A

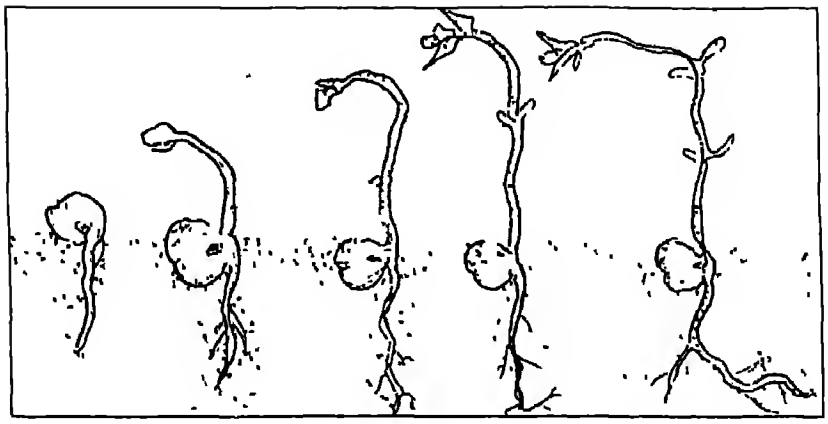


Illustration-B

Test of learning

Q 1 What is the source of energy for germinating seeds?

Q 2 Why seeds don't germinate in soil that is flooded with water?

Q 3 Is it possible to grow seeds in moist soil kept in an airtight jar?

Activity 3

OBSERVING TEMPERATURE AND SEED GERMINATION

Aim

To find out the effect of temperature on the germination of seeds

Concept to be developed: Temperature is one of the essential factors for seed germination. Different seeds need different optimum temperatures for germination.

Requirements

Radish seeds, Sunflower seeds, Wheat seeds, 9-pieces of clean cotton cloth cut into 12x12 inch squares, Water, Rubber bands, Freezer, Refrigerator, 3- thermometers

Procedure

Ask students if they have ever seen seeds planted. At what time of year the planting done? Different seeds are planted at different times of the year

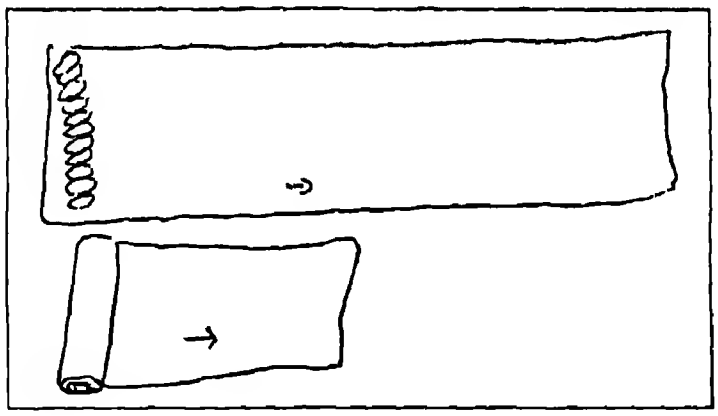
Ask the class what seeds must do before they can grow into new plants Review with the students what they learned about germination in Activity-2 Do the students think that seeds planted in the winter would

germinate? Elicit their theories Explain that, in addition to the right amount of water, seeds require a suitably warm temperature to germinate, and the temperature varies for different seeds This is one reason why seeds are planted at different times of year The students can find this out by trying the following Activity

Explain to the students that in this Activity they will try germinating seeds at three different temperatures Suggest that they can also find out if different seeds germinate at different times by using three kinds of seeds. radish, wheat, and sunflower

Have the students moisten the nine pieces of cloth and then wring them out so that no water is dripping from the cloth. Then spread the cloths out on a waterproof surface. Have the students count out three piles of each kind of seed with fifty seeds in each pile. Place each pile of fifty seeds on a moist cloth, and spread out the seeds so that they will not be in contact with each other.

Roll the cloth and fasten the ends with rubber bands. The rolls should be labeled with different numbers 1 for radish, 2 for wheat, and 3 for sunflower



Have the students place one roll of each kind of seed in the freezer in the school kitchen If there is no thermometer in the freezer, have them place a thermometer in the freezer (If no freezer is available in the school, one of the students might take the roll home and place it in the home freezer.) Next, have the students place one roll of each kind of seed and a thermometer in the refrigerator One roll of each kind of seed should be kept in the classroom at room temperature. The rolls in the refrigerator and in the classroom should be kept moist during the experiment.

in which the seeds are planted The jars should be placed in a warm part of the room Each day the students should check them for moisture, adding water as necessary to keep the material moist For ten days the students should watch the seeds for evidence of germination In a chart like the following, they should record their observations of how soon the seeds germinate, how high the young seedlings are, what structures appear, etc

COTTON

Time	Time of Germination	Height of Seedling	Other

After the students have made their final observations, encourage them to answer the following questions Did the seeds that were planted in sawdust germinate? (Yes) Did the seeds that were planted in cotton germinate (Yes) Did the seeds planted in soil germinate? (Yes) Was there any noticeable difference in the ability of the seeds to germinate successfully? Or will seeds germinate in any moist material? (As the students learned in Activity 1, seeds contain their own food supply This makes it possible for them to germinate in any moist material because they do not need additional food) as far as the students now know, what is the one requirement for the successful germination of seeds? (The proper amount of moisture)

For ten days, at intervals of two days, have the students unroll the cloths and count the number of seeds that have germinated in each set They should also make a record of the temperature in each of the places where the rolls are kept. Their observations can be recorded in a table such as the one illustrated After the students have made their final observation, encourage them to answer the following questions How many of the seeds in the freezer germinated? (None) Did any of the seeds in the refrigerator germinate? (Some of the wheat seeds may have germinated Wheat seeds may start germinating at temperatures only slightly above freezing None of the other seeds should germinate of temperatures less than 680 F) How many of the seeds in the classroom germinated? (The majority should have those that did not may have been too old, damaged, or inactive.) What kind of seed germinated first? (Radish). Can seeds germinated when they are kept below freezing? (No). Can seeds germinate in the cold? (Some seeds can germinate in fairly cold conditions. What seeds may have germinated in the refrigerator Under what conditions did most of the seeds germinate? (At room temperature) What is necessary for most seeds to germinate? (Warm surroundings)

Radish

Number of Seeds Germinating			
Days	Freezer	Refrigerator	Classroom
	Temp		
2			
4			
6			
8			
10			

Extending ideas

The children can vary this experiment by using other kinds of seeds and by varying the temperature in other ways Have the children consider the possibility of plant life on other planets They will have to find out about air, temperature, and moisture conditions on the various planets

Test of Learning

Q 1 What is role of temperature in seed germination?

Q 2 What is the optimum temperature for germination of most of seeds?

Q 3 Why do Seeds not germinate at temperatures below freezing?

Q 4 Name the seeds that can germinate at relatively cold temperatures?

Activity 4

GERMINATING SEEDS IN DIFFERENT SUBSTANCES

Aim

To find out that soil is not necessary for the germination of seeds

Concept to be developed: Seeds will germinate in any substance that is kept properly moist.

Requirements

Lima bean seeds (packaged garden seed)

Potting soil, Sawdust ,Cotton, Glass, jars, Water, Rulers

PROCEDURE

Review the germination of seeds with the students Remind them that in Activities 1 and 2 they learned that seeds need a proper amount of moisture and air to germinate successfully Do they think that seeds need soil in order to germinate? Would seeds planted in moist sawdust germinate? Would seeds germinate in moist cotton?

After the students have given their answers, suggest to the class that in this Activity they will plant seeds in these materials to see if the seeds will germinate without soil They will also plant some seeds in soil, as they did in the previous Activity The seeds planted in soil will serve as the control for the experiment

Have the students pack soil in one jar, sawdust in the second jar, and cotton in the third Make sure that the materials are not packed too tightly (The seeds require air for germination.) Next have the children plant the seeds about ½ inch beneath the surface of the material in each jar The seeds should be placed near the outside of the glass where the children can watch them to see if they germinate After the seeds are planted, each jar should be watered making sure that just enough water is added to moisten the material

Extending Idea

With some children, you may want to experiment by planting different kinds of seeds in different kinds of substances One of the substances that might be used is peat moss.

Activity 5

MOISTURE CONTENT IN FOOD MATERIALS AND FOOD SPOILAGE

Aim

To establish relationship between moisture content of the food materials and their spoilage.

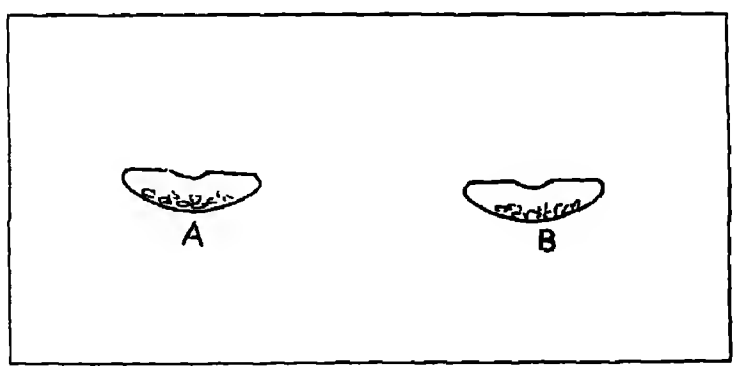
Concept to be developed: High moisture content in food items increases the growth of microorganisms, which results in food spoilage.

Requirements

Two pairs of petridishes and dry pulse seeds.

Procedure

Students are asked to label the petridishes A and B. Let students place 10-dry seeds in A and 10-wet seeds in B. These petridishes should be kept in a cool and dry places Ask students to observe the seeds at two day intervals for 10-days and record their observations. Interpret observations giving reasons



Observe them at two-day intervals for a fortnight Record your observations for the shortest to the longest shelf life of each food item under above-mentioned conditions

Extending Ideas

Knowledge of perishable food items is essential to devise a suitable method of their storage Perishable foods have a short shelf life A suitable method can retain their nutritive quality and also prolong their shelf life Common methods employed for preservation of perishable food items include Cold storage, dehydration irradiation, pasteurization and canning The apple can be nutritionally stored through canning Students may do to ascertain it

Test of learning

(a) Give five examples for each perishable and non-perishable food items?

(b) Why do perishable food items get spoiled under hot and humid conditions?

Activity 6

SHELF LIFE OF FOODSTUFFS

Aim

To test the longevity of perishable foods.

Concept to be developed: every food item has its own shelf life, thus storage must be planned accordingly.

Requirements

Some fruits such as apple, banana, guava, and bread, butter, etc.

Procedure

Clean and keep the above materials under following storage conditions

(a) Inside the refrigerator

(b) Inside the hot and humid kitchen-room.

Extending ideas

Fleshy fruits such as banana, guava and apples have high moisture content in them. Green vegetables also have high moisture content. If such food - stuffs get stored at room temperature. The moisture content and heat would encourage the growth of microorganisms on these foodstuffs. It results in food spoilage High moisture content in foodstuffs also promotes sprouting of stored grains, potatoes and onions. Thus, are has to know the maximum permissible levels of moisture of each food material to ensure proper storage For food grains, such as rice, jowar, ragi, and wheat the internal moisture levels should not be higher than 14% during storage.

Test of learning

Q. 1. Why apples get spoiled earlier than beens stored at room temperature?

Q 2 Why do daals stay a fresh during winter and summer but get spoiled during rainy seasons?

Q 3 Why do microorganisms develop in stored food stuffs?

Organization of the living World

J. P. Narayan
Lecturer in Botany

Overview

A variety of molecules form different components of a cell Cell is a basic unit of both structure and function of plants and animals (excluding viruses) There are some unicellular organisms Life processes in those are completed within a single cell while in multicellular organisms, various levels of structures are present Many cells form a tissue, tissues aggregate to form an organ, several such organs constitute an organ system Many organ systems, each specialized for performing a particular work, make an organism

Organisms live in a variety of habitats such as land, fresh water, oceanic water and air There is a hierarchy of organisation in nature comprising various levels from molecular to ecosystem and biosphere These levels exhibit interaction and are mutually interdependent

Biosphere is the thin mantle of the earth and the part of the atmosphere in which living organisms exist. It is the largest biological system comprising all living and non-living components. On account of this, biosphere is sometimes defined as the sphere of living matter together with water, air and soil, which they inhabit. Each component of the biosphere has certain specific functions The totality of all such functions gives the biosphere a functional stability.

To understand the structure and function of the biosphere, developing familiarity with the following concepts is necessary Sum of individuals of any species at a particular place form its **population** (e g. human population). The various populations of different organisms in a particular area form a **community**. For example, populations of teak wood, rose wood and other trees in the forest constitute a community Communities of animals and plants interact among themselves and with their physical environment as a functional unit. This interaction of living and non-living components as a system is called an **ecosystem** (e g pond, lakes or forest) Ponds and lakes are examples of **aquatic** ecosystems and forest is an

example of a **terrestrial** ecosystem Bigger biotic communities or ecosystems spread over a large geographical area are called **biomes** (e g : the desert biome, the tropical rain forest biome)

All the biomes of the earth are inter-related and they interact together as a bigger unit constituting a single large self–sustaining biological system called the **biosphere** The biosphere thus includes all microorganisms, plants, animals and human beings.

Activity – 1

STUDYING THE STRUCTURE & FORMS OF VARIOUS ORGANISMS

Aim

To observe unicellular, filamentous and multicellular organisms.

Concept to be developed: Living organisms are highly diversified. Some are unicellular and life processes in them are completed within a single cell, while many are multicellular and complex. They have specialized organs for specific physiological functions.

Requirements

Preserved materials of Chlamydomonas, Volvox, Yeast, Ulothrix and dicot leaves, forceps, blades, glass slides, cover slips, brust and a compound microscope.

Procedure

Ask students to make whole mount preparations of Yeast cells, Chlamydomonas, Volvox, and Ulothrix. Let them observe slides under low and high powers of compound microscope. Students can study the cellular status of various organisms. They can also count the numbers & types of cells present in organisms under study and compare them with types of cells present in T S of dicot leaf Students must be helped in this endeavour by teachers Teachers can explain them to differentiate various cells present in organisms under study.

Observation Table

Name of organisms	Approximate No. of cells present	Types of cells	Outline diagram

Extending ideas

Suggest students to establish specific physiological roles of various cell types of a Dicot – plant

Test of learning

Q.1 How are cells arranged in a Volvox colony?

Q 2 Name the apical cell and the basal cells of Ulothrix filament? Assign their roles?

Q 3 How many types of cells are present in a dicot leaf?

Activity – 2

IDENTIFICATION OF THE VARIOUS TYPES OF LOWER ORGANISMS

Aim

To make students recall various types of lower organisms as constituent of the living world

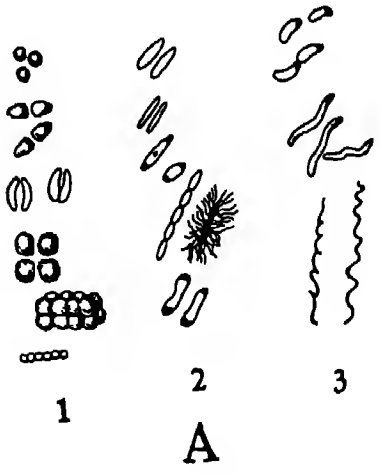
Concept to be developed: Various types of organisms are present in this living world. They are inter-connected through food chain and food webs. They co-exist with mutual tolerance. Lower organisms are as important as higher organisms in maintenance of an ecosystem.

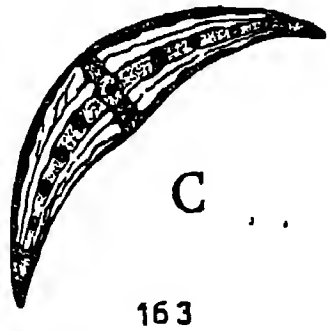
Requirements

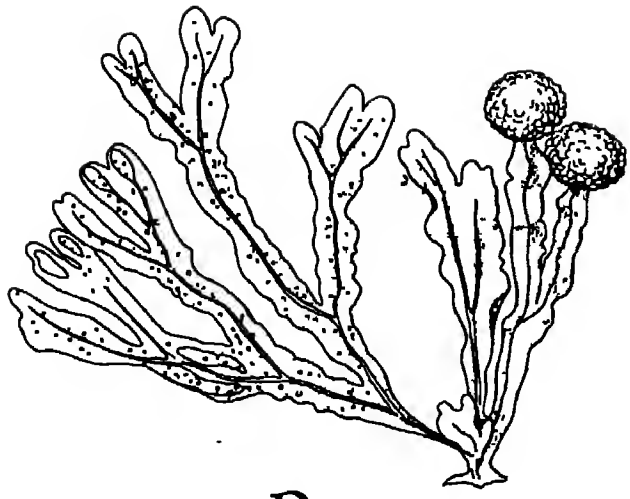
Specially designed charts

Procedure

Ask the students to identify alphabets and numbers pointed out in the illustration charts. Their answers can be evaluated. Repetition of above said activities at particular intervals would help students in revision of the subject







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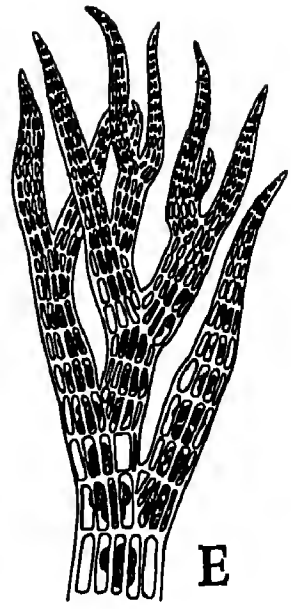

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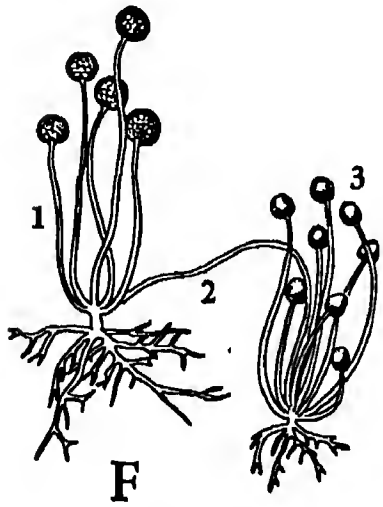

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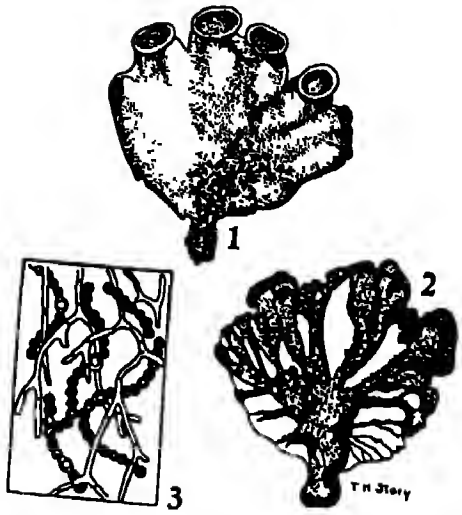

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Activity – 3

IDENTIFICATION OF THE VARIOUS TYPES OF CELLS PRESENT IN PLANT KINGDOM

Aim

To make students understand the variety of cells present in plant kingdom.

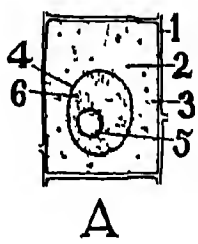
Concept to be developed: A variety of cells make a multicellular organism. Similar kinds of cells make a tissue. These are initial steps in organization of the living world.

Requirements

Specially designed charts.

Procedure

Ask students to identify alphabets and numbers pointed out in the illustration charts. Their answers can be evaluated.



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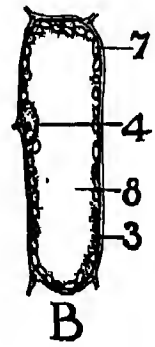

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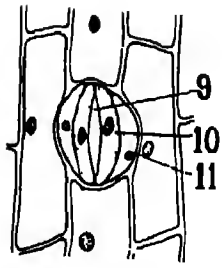

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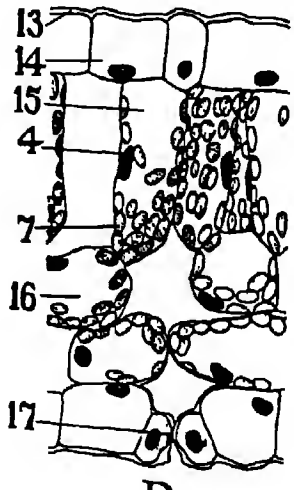

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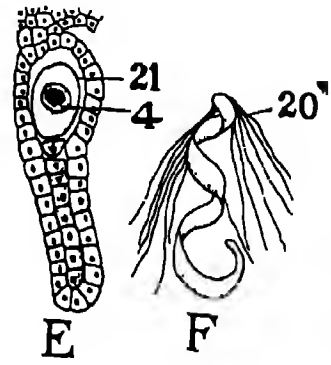

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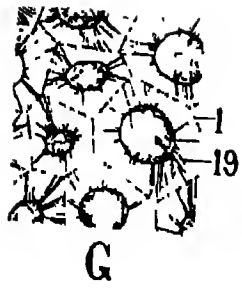

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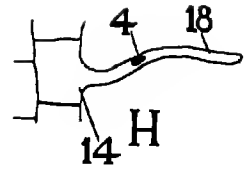

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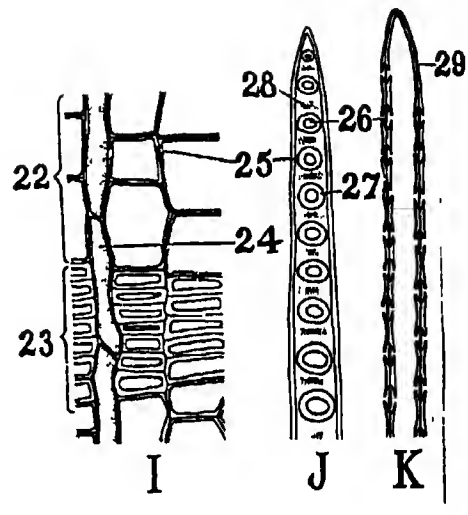

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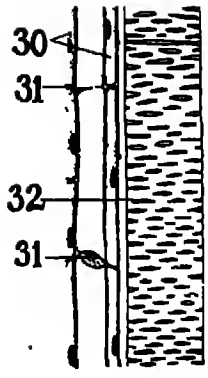

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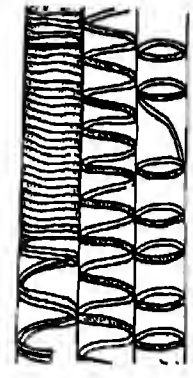

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Activity – 4

IDENTIFICATION OF VARIOUS ORGANISMS PRESENT IN THE AIR

Aim

To observe aeromicroflora.

Concept to be developed: Atmosphere is an essential component of biosphere. Atmosphere is made up of various gases, in addition to gases it also contains various organisms. These organisms are called aeromicroflora.

Requirements

Glass slides, cover slips, forceps, needles, suitable stains, compound microscope, glycerin, blotting papers.

Procedure

Ask students to clean five glass slides. Put few drops of glycerin and stain on each glass slide. These slides should be placed at various places such as inside the laboratory, gardens, along the roadsides, close to human settlements and polluted areas. Slides should be collected from above said places after one hour and brought to the laboratory. Cover slips be placed and these slides should be observed by students. Let them record their observations in following observation table:

S No	Location	Types of organisms/debris		Inference
		Living	Dead	

Test of learning

Q 1 What types of living organisms are present in air?
Q 2 What types of debris are present in air?
Q 3 How do aeromicroflora adapt to air?
Q 4 write their significance in living world?

Activity –5

IDENTIFICATION OF VARIOUS ORGANISMS OF WATER

Aim

To observe structure and adaptation of aquatic organism

Concept to be developed: Three parts of our planet are covered with water. These water bodies contain a variety of living organisms. They range from single cell alga to multicellular gigantic whale. These organisms are adapted to aquatic life. They have various structural and physiological modifications.

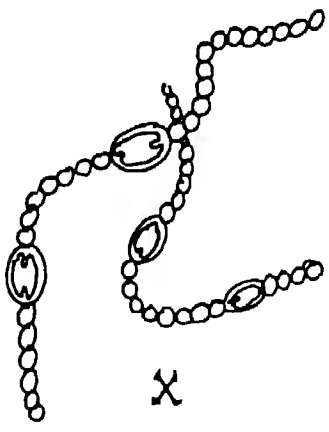
Requirements

Glass slides, cover slips, pond water, suitable stains, needles, forceps and a compound microscope

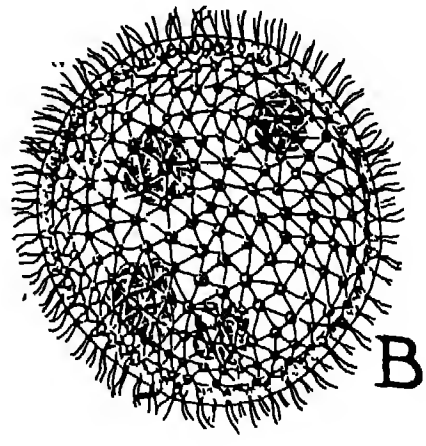
Procedure

Ask students to collect pond water. They can identify some floating organisms which can be seen through necked eyes. A list with illustrations can be prepared of those organisms. Let them put one drop of collected water on two three glass slides. Put cover slips on slides and observe under low and high powers of compound microscope. They can be helped in identification by class teachers Students be provided with a chart of illustrations of some common microscopic aquatic organisms, which can be used to identify the slide organisms.

Pictographic depictions of microscopic aquatic organisms



X



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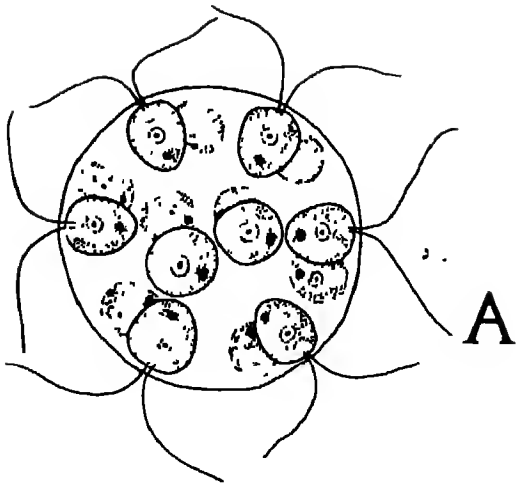
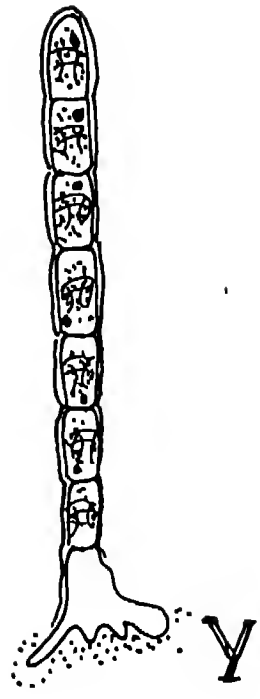




Extending ideas

Ask students to observe and note down adaptive features of aquatic organisms that make them survive in water. Their specific observations can be recorded in the following observation table:

S.No.	Names of microscopic aquatic organisms	Adaptive features	Unicellular/Filamentous colonial/multicellular

Metals and Non-Metals
Class VIII & X

Dr. R. K. Parashar

1. Overview

There are about 114 known elements, these elements are classified into two classes metals and non-metals. Except 22 all other elements are metals In the present module, a few concepts related to the physical and chemical properties of metals are discussed with suitable teaching methods.

2. Objectives

After going through the module, you will be able to help your students to

- classify the elements into metals and non-metals,
- describe the physical and chemical properties of metals;
- infer about the relative react ivies of metals;
- distinguish between ores and minerals;
- explain the term metallurgy;
- describe the extraction of aluminum and iron from thus respective ores.;
- list different types of alloys and their uses;
- explain reason for corrosion and apply ways and means to check corrosion;
- describe the physical and chemical properties of non-metals;
- assemble apparatus for preparation and studying properties of H_2, NH_3 and H_2SO_4 and
- describe extraction of sulphur and study its properties

3. MAJOR TEACHING POINTS/CONCEPTS

The concepts covered in this module are as under

3.1 Metals

1. Metals are solids, hard and heavy
2. They have a characteristic shine called 'metallic Luster"
3. Metals are malleable and ductile

4. They are good conductors of heat and electricity
5 Metals are electropositive elements
6. Metals differ in their reactivity with O_2, H_2O, acids, Cl_2 and H_2
7 Placement of metals in activity series
8 Ores and minerals
9 Metallurgy – Extraction of metals from their ores.
10. Corrosion

3.2 Non-metals

1. Non-metals may be solid, liquid or Gas at room temperature
2. Non-metals are brittle
3. Non-metals are non-ductile and non-malleable
4. Non-metals are bad conductor of heat and electricity
5. Non-metals are electronegative elements
6. Non-metals react with O_2, Acids, Cl_2 and H_2
7. Preparation, properties and uses of H_2, NH_3, S, SO_2 and H_2SO_4

4. TRANSACTIONAL STRATEGIES OF CONCEPTS

The teacher can use demonstration cum-discussion/activity method according to the resources available in dealing with major concepts discussed here.

4.1 Physical Properties

The concepts related with the physical properties of the metals and non-metals like.

1. Metals are solids (except Mercury) hard and heavy
2. Metals are lustrous
3 Metals are malleable and ductile
4. Metals are good conductors of heat and electricity
5. Non-metals may be solid, liquid or gases at room temperature
6. Non-metals are brittle, non ductile, nonmalleable and are poor conductor of heat and electricity.

Transited by demonstration method by using samples of some metals, metal sheets, wires Non-metals to show their properties for the conduction of heat and electricity by usual methods.

Testing RLOs

1 Explain four situations where you apply the malleability properties of metals.
2. Explain four situations where you apply the ductility properties of metals.
3. Why metals are good conductor of heat and electricity?
4 Why metal surfaces are lustrous?
5 Which metal container is used for transportation of mercury?

4.2. Reaction with Oxygen

Almost all metals react with oxygen to form metal oxides. Generally metal oxides are basic in nature. All metals do not react with oxygen with same speed metals react with O_2 at room temperature are Na and K. the reaction is so vigorous that there metals catch fire if kept open in air. Hence these metals are stored in kerosene oil

At ordinary temperature surfaces of metals like Mg, Al, Zn, Pb etc. react with oxygen o form a thin layer of metal oxide, which prevent further reaction of metal with oxygen On heating to ignition temperature Mg metal burns in air giving intense heat and light Zn metal burns in air only on strong heating Fe, Cu, Ag and Au do not burn even on strong hearting.

Testing RLOs

1 Why are Sodium and Potassium kept immersed in kerosene oil ?
2. Give two examples each of acidic, basic and amphoteric oxides. Write chemical equation of their preparation.
3 Why ornaments are made of Gold and Silver metals?

4.3. Reaction with water

When a metal react with water, a metal oxide or hydroxide and hydrogen gas are formed. Some metals (Na and K), react with cold water, some react with hot water (Mg), some reacts only with steam (Zn and Fe) whereas others (Cu, Ag and Au) do not react even with the steam

Testing RLOs

1 Write the chemical equation of reaction of Na, Mg and Fe with H_2O
2. Why water carrying pipes are made of iron?
3 Why aluminium containers are preferred than steel containers for heating water?

4.4. Reaction with dilute acids

When a metal reacts with a dilute acid, then a metal salt and hydrogen gas are formed. Some metal(Na, K) react vigorously, some metals (Mg) react rapidly. Some metals (Zn, Fe) react on heating. Whereas others (Cu, Ag and Au) do not react at all.

From the above chemical properties no. (1), (2) & (3), we find the order of reactivity of these metals is
Na > Mg > Zn > Fe > Cu

Testing RLOs

1. Write the chemical equation of reaction of Na, Mg, Zn, Fe and Cu with dilute and concentrated HCl and H_2SO_4.
2. Whether HCl can be stored in copper vessel?

4.5 ACTIVITY SERIES OF METALS

The above chemical properties give idea about the relative reactivities of different metals. The sequence of reactivity can further be confirmed by following displacement reactions

Displacement reaction

A more reactive metal displaces a less reactive metal from its salt solution

The following chemical reactions can be demonstrated to establish the reactivity series

$CuSO_4(aq)$ + $Zn(s) \longrightarrow ZnSO_4$ + $Cu(s)$
Blue colourless red brown

$CuSO_4(aq)$ + $Fe(s) \longrightarrow FeSO_4$ + $Cu(s)$
Blue Greenish red brown
Soln

$2AgNO_3(aq)$ + $Cu(s) \longrightarrow Cu(NO_3)_2$ + $2Ag(s)$
Blue White

Testing RLOs

1. Arrange Cu,Zn, Fe and Ag in increasing order of reactivity.

Evaluation in Education

Dr. A. B. SAXENA

Measurement

- It is the process of assigning a number to an object according to a definite rule/system.
- Measurement of a physical quantity is different from educational measurements in some respects.
- Evaluation is different from measurement.
- There are some definite advantages of making measurement over qualitative observation: communication is more specific, mathematical tools could be used for statistical analysis, measurement is more objective than observation, and it is economical.
- Testing is done according to a standardized procedure, and it gives a score. The procedure must be fixed, predecided and applied uniformly over all subjects.
- Different tools are used in different domains:
    - Cognitive : Paper pencil test, problem solving, concept maps, application tests etc.
    - Affective: Observation scale, Rating scale, Attitude scale, problem situation, description test etc.
    - Psychomotor: Observation, performance test, Problem situation, rating scale etc.
- There could be various purposes of making measurement in evaluation. Some of these are a) To know the previous knowledge, learning gaps, misconceptions, final achievement v) To assess efficacy of teaching programme, weakness of teaching procedure etc. c) To compare the efficacy of various programmes/approaches of teaching d) To provide feedback to the learner and their parents, e) To plan the future programme and f) To rank order the learner according to their knowledge/achievement.

- There are four kinds of scales: Nominal scale, rating scale, Interval scale and Ratio scale.

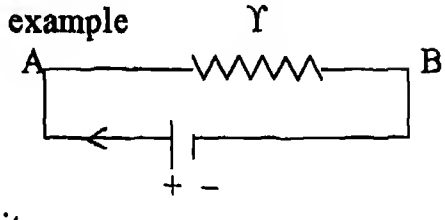
- In cognitive domain paper-pencil tests are most frequently used. They involve essay – type and objective type test items.

- Essay type test items are easy to make, take less time to prepare, difficult to be valued uniformly and inter – scores reliability in low. By taking some steps these could be improved on these aspects.

- Objective test items are difficult to prepare, easy and quick to score and have high inter-scorer reliability.

While making objective test items, 1. language should be simple. Each question should be complete in itself, instructions should be clear, and must use simple language. Tricky language, confusing phrase, ambiguous words should be avoided. The test item must be framed keeping in mind clearly what is to be tested.

- All kinds of objective test items are not equally efficient nor they can test all aspects such as application, analysis, understanding of a principle. Multiple choice type test items can be used for large variety of purposes. There are many variation in multiple choice type questions also. For example

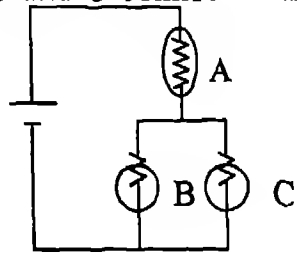


a) The current in the circuit shown is
   i. Maximum at point A
   ii. Minimum at point B
   iii. Equal at all points in the circuit
   iv. Minimum in resistance r.

Give reason for your answer _____

_____

b) Figure shows three/identical bulbs A,B and C connected in a circuit. If bulb B get fused,



   i. Bulb A will get diminished
   ii Bulb A will become bright

If you have chosen i) which of the following is correct:

i. Bulb C would be bright
ii. Bulb C would get diminished
iii. There would be no change in the intensity of bulb C.

If you have chosen ii) which of the following is correct:

i. Bulb C would become bright
ii. Bulb C would become dim
iii. There would not be any change in the brightness of the bulb C.

Give reason for your answer _____

_____

_____

❖ Common precautions that are to be taken while framing multiple choice type test items are:

a) Stem of item must be clear, specific and complete in itself.
b) Unnecessary information should be avoided in the stem.
c) Negative statements are to be avoided, unless necessary.
d) All possible responses – correct response and distracters – must grammatically go well with – the stem.
e) Only one possible response must be right clearly and all others clearly wrong.
f) All distractors must look plausible.
g) Correct response must occur at all places with equal probability.
h) Phrases such as, 'In your opinion', 'generally' should be avoided.
i) Options such as ' All the above' and 'none of the above' should be avoided.

❖ **Evaluation is of different types:** Formative evaluation, Summative evaluation, Diagnostic evaluation, Achievement evaluation Micro and Macro evaluation. They have different purpose. .

❖ According to the objective of the evaluation, the tests are prepared and/or tools are used. For summative evaluation test are prepared to se the sum total of the progress hence end point objects are in sight. For diagnostic evaluation, each step of development is to be checked. Micro level evaluation is related to progress of the individual whereas Macro level evaluation overlooks individual progress but takes care of the trends of the

entire population Formative evaluation could be formal as well as informal.

❖ **Draw backs in the present evaluation system**

- Lack of reliability and validity
- Non-cognitive areas are ignored
- Raw scores are not true representative of achievement
- Zero/100 does not represent faithfully the achievement.

Grading

There are two types of grading . i) Direct Grading ii) Indirect Grading

(a) Absolute grading Example on 9-point scale

S. No.	*Letter of Grade*	*Range of marks*	*Description*
1	*A*	*90% and above*	*Outstanding*
2	*B*	*80% to less than 90%*	*Excellent*
3	*C*	*70% to less than 80%*	*Very Good*
4	*D*	*60% to less than 70%*	*Good*
5	*E*	*50% to less than 60%*	*Above Average*
6	*F*	*40% to less than 50%*	*Average*
7	*G*	*30% to less than 40%*	*Below Average*
8	*H*	*20% to less than 30%*	*Marginal*
9	*I*	*Below 20%*	*Unsatisfactory*

(b) Relative Grading Example on 9-point scale

S.No.	*Letter of Grade*	*Interval*	*No of Cases*	*Grade Value*
1	*A*	*1 75σ to ∞*	*4%*	*9*
2	*B*	*1.25σ to 1 75σ*	*7%*	*8*
3	*C*	*0.75σ to 1.25σ*	*12%*	*7*
4	*D*	*0 25σ to 0 .75σ*	*17%*	*6*
5	*E*	*– 0.25σ to 0 25σ*	*20%*	*5*
6	*F*	*– 0 75σ to – 0 25σ*	*17%*	*4*
7	*G*	*– 1.25σ to – 0.75σ*	*12%*	*3*
8	*H*	*– 1 75σ to – 1 25σ*	*7%*	*2*
9	*I*	*∞ to –1 75σ*	*4%*	*1*

Advantages

- Grades so awarded will indicate the relative position of the individual student vis-à-vis peer group and thus serve the purpose of norm referencing
- Comparison across curricular areas possible.
- Grades record faithfully the progress with – time
- Grade point average GPA have additive characteristics
- Difficulty level of the test does not affect the grade

❖ **N.C.E.R.T.'s proposed model**

Nine point relative grade model has been proposed by NCERT

❖ **C.B.S.E.'s proposed model**

It is almost same as NCERT's model, with slight variation, that too only in regard to its operational dimension. CBSE's model proposes an artificial dichotomy by declaring C_2 and above grades as qualifying grades and three bottom grades normally D_1, D_2 and E as unsatisfactory grades. Students who secure qualifying grades in at least four subjects including a language in class X are awarded the certificates while all others are given statement of performance

❖ **Making of merit list with grades**

Using the table below, GPA is calculated for each student

Sr. No.	Letter Grade	Grade Value
1	A	9
2	B	8
3	C	7
4	D	6
5	E	5
6	R	4
7	G	3
8	H	2
9	I	1

If merit list is to be prepared to give admission in a particular stream, say science, weighted GPA (WGPA) is calculated. Accordingly merit list could be prepared.

❖ **Blue Print**

The following steps are taken to prepare the blue print

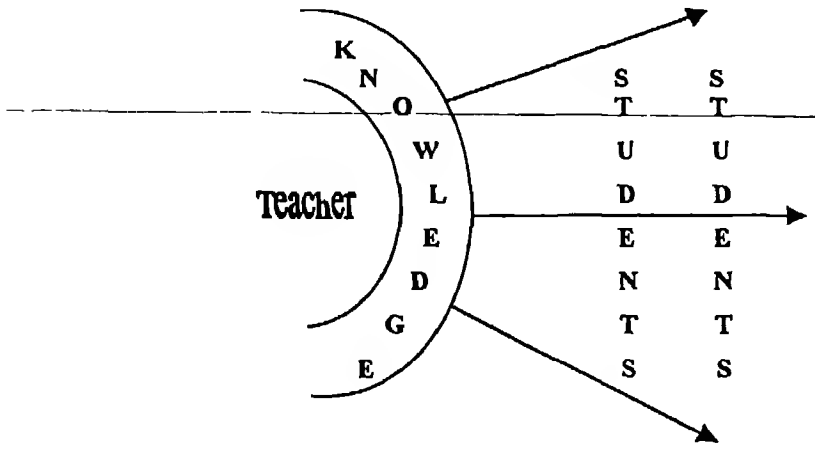
- Decide the relative weightage of each unit.
- Decide the relative weightage of essay type objective type test items to be given
- Accordingly the marks of which test items of each type are to be made is decided
- Relative weightage of different questions testing knowledge, under standing comprehension ..... Application is decided
- Following the previously used methods total scores of each kind of questions are calculated. The table showing blue print is filled up. See example
- While preparing the test items for each unit, blue print serves as guide – line.

Unit	Relative Weightage	Essay Type	Objective type test items			Knowledge	Understanding	Comprehension	Application
			M C	Short Anaswe	Very Short Answer				
1	10%	4%	3%	2%	1%	1%	2%	3%	4%
2	20%	8%	6%	4%	2%	2%	4%	6%	8%
3	30%	12%	9%	6%	3%	3%	6%	9%	12%
Total	100%	40%	30%	20%	10%	10%	20%	30%	40%

IMPLICATIONS OF RESEARCH FOR SCIENCE TEACHING

Prof. A.B. Saxena

1. Transmission Model



Assumptions:

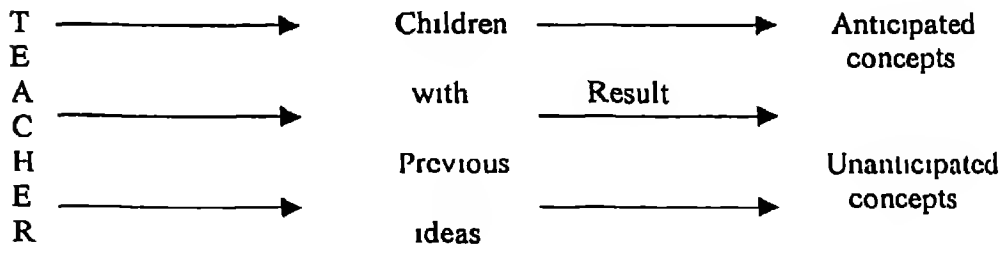
- ✓ Students with blank mind slate.
- ✓ Teacher is the source of knowledge
- ✓ Knowledge is gained passively in the same form, as such, without distortions.

Learner is passive.

Conclusion

Good lecture + demonstrations etc. result in efficient teaching/learning

Is this true?



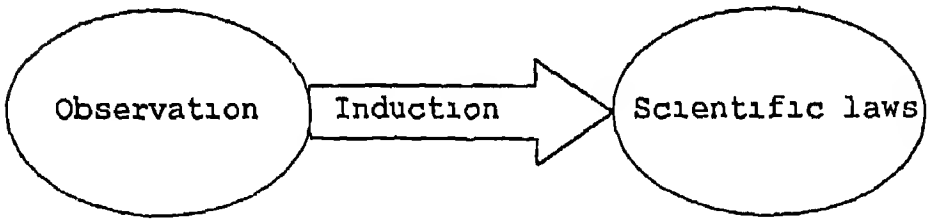
2. Discovery method of teaching

- ✓ For deeper understanding
- ✓ Scientific process
- ✓ Pre-decided objectives?
- ✓ Is it the right answer?
- ✓ Time?
- ✓ Feasible ?
- ✓ Students' capability.

Assumption

- ✓ Logical positivism or empiricism

  Careful observation and experimentation can lead to discovery of truth about the universe around us.



Objective?
Facts immutable?
Creativity?
Human construction of knowledge

Shall we go back to traditional teaching?

3. The understanding

What is science?

Systematic collection of facts?
Systematic ideas 'discovered'

Understanding ?

Ability to
1. 'See'
2. Construct mathematical model
3. Connect with existing ideas
4. Apply.

Nature of understanding

- ✓ Context dependent
- ✓ Non binary ?
- ✓ Accommodation?
- ✓ Concept, Procedure
- ✓ Depends upon mathematical knowledge
- ✓ Stability of conceptual framework depends upon sensory and linguistic experiences

Levels of understanding

1. Sound understanding
   - -Knowledge of all elements,
   - -Relationships
   - -Problem solving
2. Partial understanding
   - -Knowledge of some elements
   - -No misconceptions
3. Partial misunderstanding
   - -Partial understanding
   - +
   - Some misconceptions
4. Complete Misunderstanding,
   - Misconceptions only

5. No understanding.

Scientific Understanding

1. Draw inferences and explanations in diverse conditions.
2. Not absolute, but comparative
3. Basic premises are well defined ; deductive based on these.
4. Cannot be tested using single test

Failure why?

1. Appropriate schema absent
2. Desired schema not elicited, not enough hint.
3. Alternative, competitive schema
4. Too difficult schema
5. Not enough emphasis

4. Characteristics of students' ideas

- Ideas are stable. There could be many possible causes
- Ideas are context specific.
- Sometimes ideas are developed prior to teaching.
- Ideas are personal

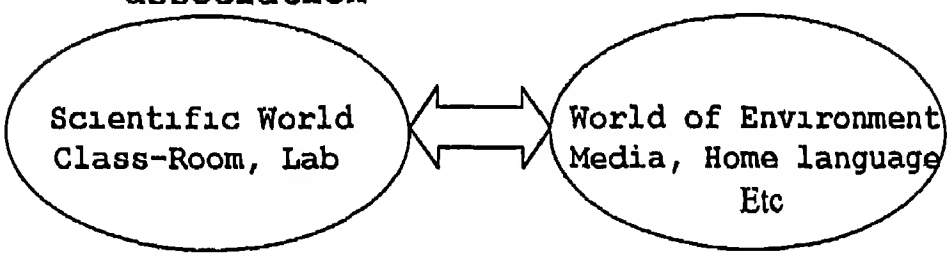
How can we know about students' ideas?

- Paper and pencil test

- Interview
- Concept map
- Computer tasks
- Students' statements/questions

Possible Origins

- Kinesthetic or sense experience
- Metaphoric language
- Non-Scientific description in mass-media
- Induced in-correct generalization
- Linguistic inference and word association



5. Common Alternative Frameworks (AF)

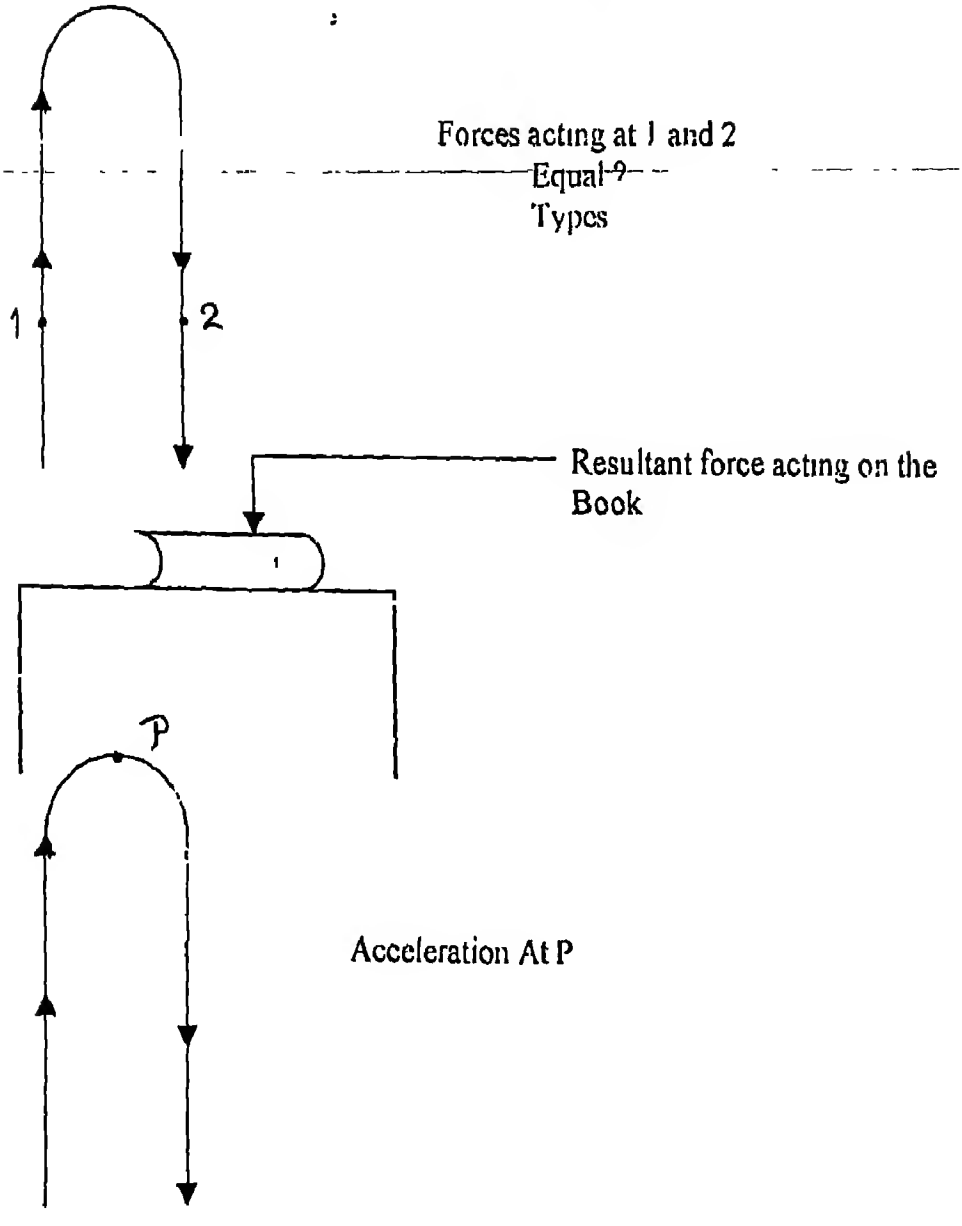
- Lighting OF bulb with one wire
- Models of current

a) Clashing of current
b) Consumption of current
c) Sharing of current
d) Scientific model

(Shipstone 1984)

- Constant Current source
- Sequence model
- Non-conservation of current

❖ Series and parallel connections.



Constructivist Approach

- ❖ Knowledge is constructed.
- ❖ Concepts are modified/reinforced with every new experience.
- ❖ Concept development is life-long continued process.
- ❖ Knowledge is idiosyncratic process.

- Process of development of AFs and conceptions is same.
- Due to different cognitive ecology, same experience is interpreted differently by different persons.
- Process of concept formation is continuous process of successive approximations.

In the classroom

- Maximize student participation.
- Let the student state their ideas without inhibition or fear of evaluation.
- Students are encouraged to discuss and debate pros and cons & implications of various ideas.
- Pure lectures are reduced to minimum
- To overcome misconception, the teachers ask student to think aloud, make hypothesis, test evaluate their own ideas.

	Traditional view	Constructivist view
Learner	Passive	Active
Knowledge	External to learner absolute	Constructed by the learner personal, idiosyncratic
Curriculum	Is not learnt	Set of activities to construct knowledge
Misconceptions	Mistakes	Misinterpretations of world of ideas.

Points of focus

- What are the common misconceptions related to concept in question?
- What should be the role of the teacher in view of misconceptions?
- What could be the activities in the light of AF to make learning more meaningful?

6. Essential Steps of conceptual change

- Elicitation of students' ideas.
- Situation for testing students' ideas and cognitive conflict.
- Introduction of new ideas.
- Application and testing of new ideas.
- Comparison of ideas.

Diagnostic Test

(i) Before teaching:
To know preconceptions

(ii) During teaching
why learning is not satisfactory

(iii) After teaching:
to know gaps in learning

Types of diagnostic test

i) Paper and pencil tests

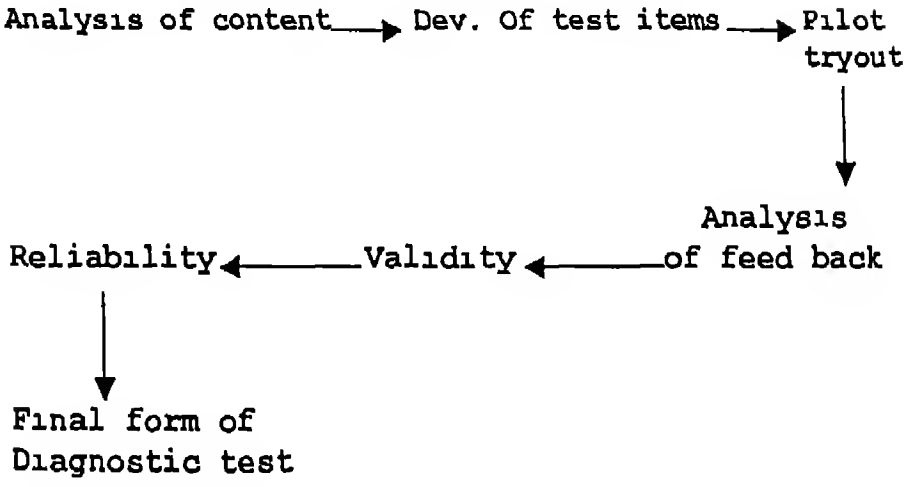
ii) Free body diagram

iii) Interpretation of diagrams

iv) Concept map

v) Combinations of the above

Development of diagnostic tests



Conceptual Change

Necessary Conditions

- Dissatisfaction with existing conception.
- New conception is intelligible.
- New conception appears plausible
- New conception is fruitful

(Posner et al.1982)

Means

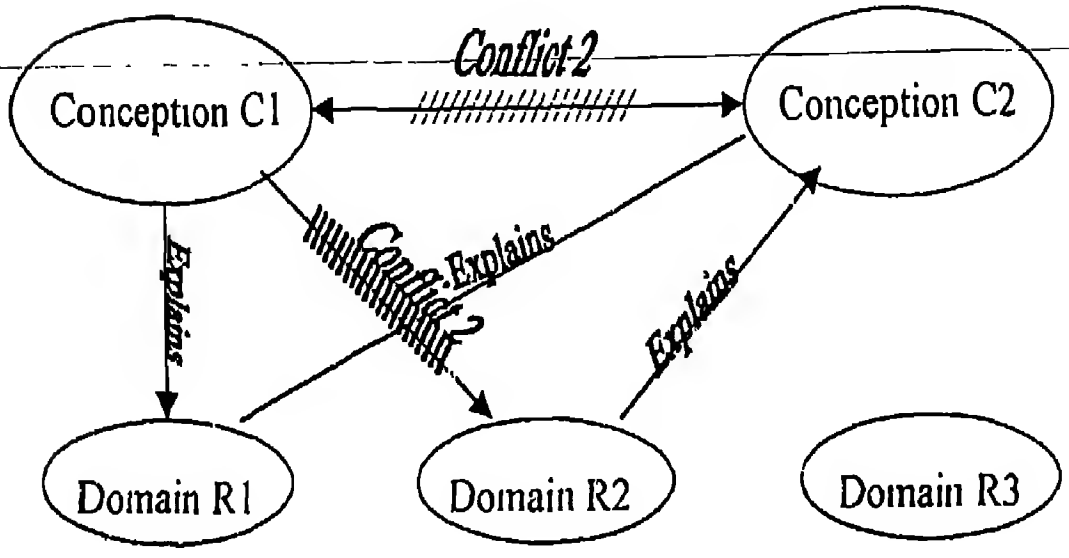
- Lab experiences
- Demonstrations
- Analogies and structured curriculum

Process of conceptual change

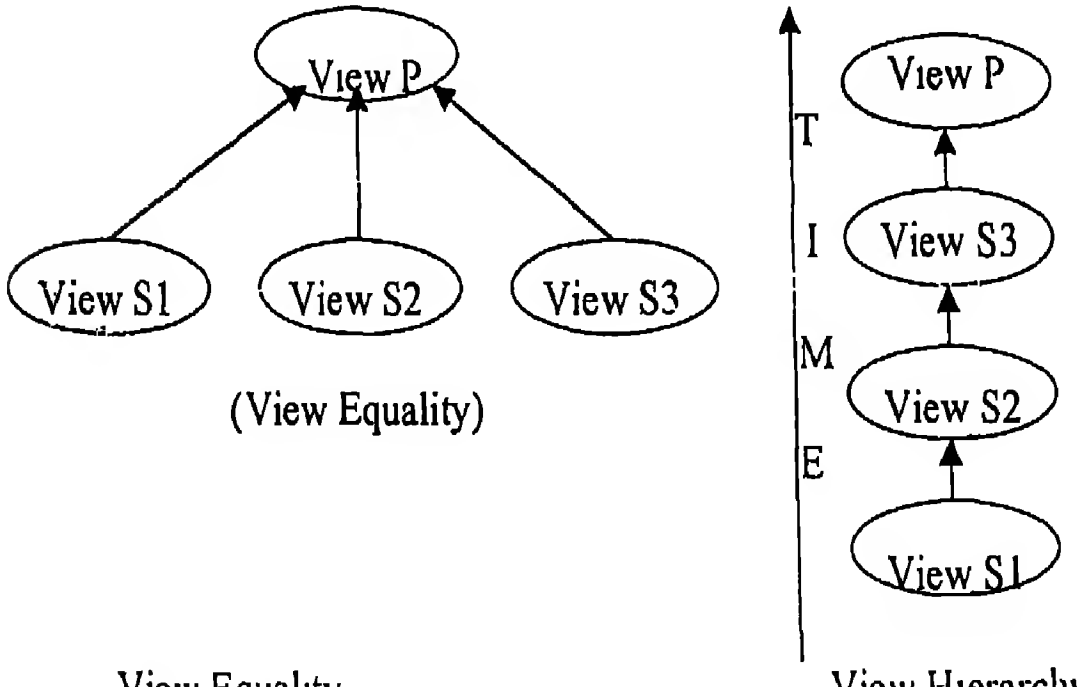
1) Discarding old conception

ii) Acceptance of new conception

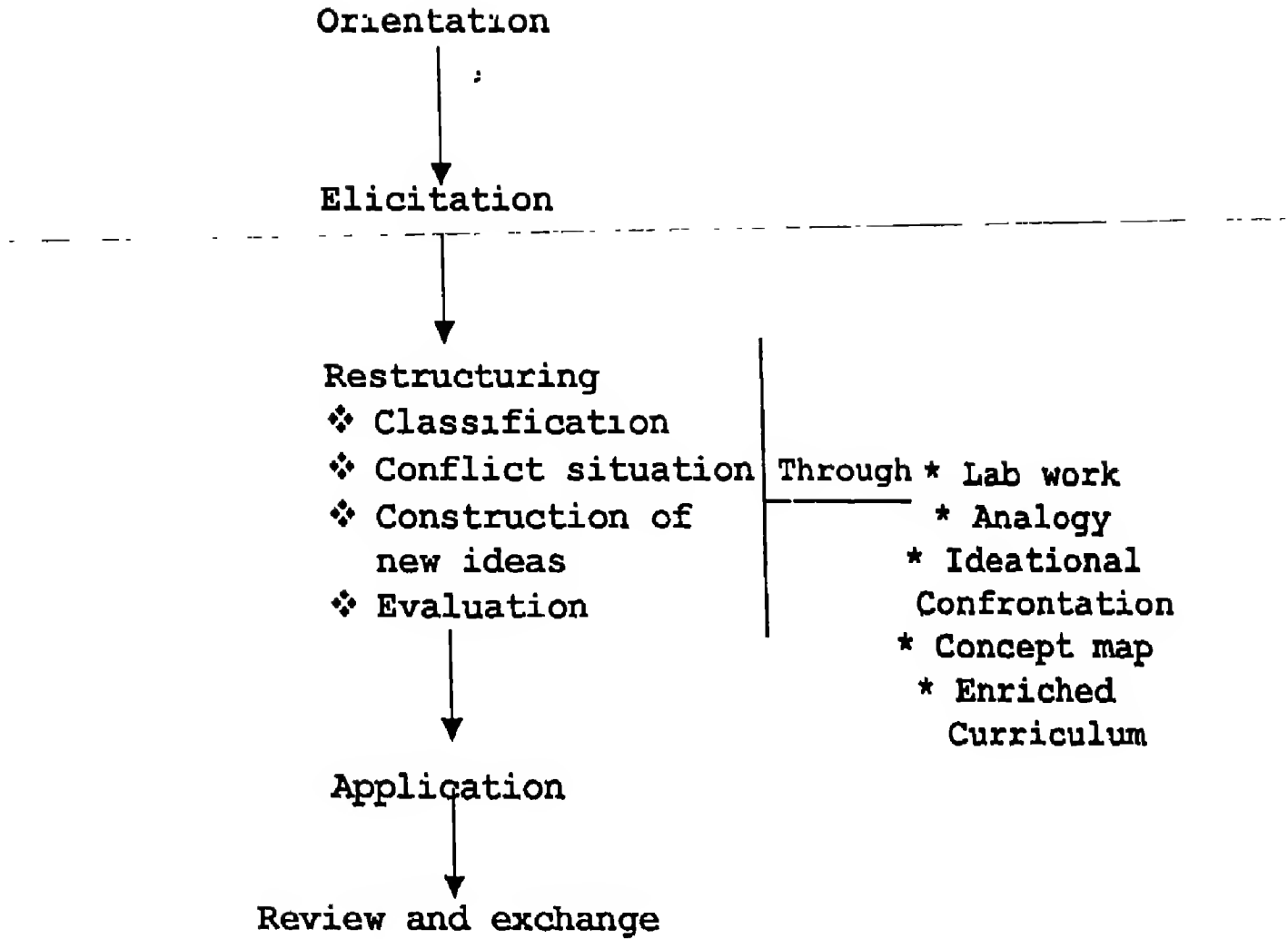
iii) Conflict between old and new acceptance of new conception



A model for conceptual change based on Hashweh (1986). Conflict 1 and 2 are to be resolved for conceptual change



Two routes for conceptual change (Thornton 1995)



Model for Conceptual Change

7. Teacher's role in constructivist teaching

1) Qualitative learning Vs Quantitative learning
2) Help to explicate and elaborate ideas
3) Plans according to non-viable constructs
4) Encourages tentative and contingent view of scientific knowledge

Six Steps for Conceptual Change

Step 1: Investigate AFs
Step 2: Provide opportunities to clarify ideas
Step 3: Provide situations that contradict AFs
Step 4: Encourage discussion; logical thinking
Step 5: Guide to conceptual change
Step 6: Re-evaluate new under-standing

Curriculum Development

Focus of attention

- Structure of thought, along with structure of discipline.
- Psychological order of discipline as a contrast to logical order.
- Alternative frameworks and their implications
- Opportunities to test ideas

Curriculum Transaction

Do's Encourage	Don'ts Avoid
- Children activities, -participation -Discussion -Deduction of implications of ideas -Testing of ideas/ implications.	-lecture -transmission of knowledge -Passive learning -ignorance of students' ideas

Implications

Teacher Education

a) Strategy
   * Identification of AF
   * Suitable methodology
   * evaluation

b) Teacher's attitude
   - Interactive/cooperative learning
   - Creative/restructuring endeavour
   - Hypothesis making, coherent knowledge

Increasing Pupil Participation in Class

Dr. V. P. Gupta

1. Introduction

Excellent teachers like Dr S Radha Krishnan and Prof S M Mukherjee have been the born teachers However, better teachers can be prepared by exposing and training them in different skills, which accelerate the process of learning Generally it is observed that many students are sitting quite inert in the class and do not participate in classroom processes They are physically present in the class but their thoughts are elsewhere Mind is very fast and it travels at a very fast rate Within fraction of a second it crosses provincial and national boundaries. We teachers are busy in discussing important concepts in the class and the students are mentally busy somewhere else i e learners are not attentive It is, therefore, suggested that teachers pay attention to such students and act in a manner, which helps in pupil participation in the class Such an action/behaviour on the part of teacher, which helps in pupil participation in the class, is known as skill of pupil participation

Any action/behaviour on the part of teacher, which attains the stage of saturation so as to increase pupil participation in the class, is known as skill of pupil participation.

Broadly speaking, the following two skills can be very useful in increasing pupil participation

1 Skill of stimulus variation

2 Skill of Dealing with pupil response

A brief discussion on different components of these skills may be useful in achieving our objectives as given below

Stimulus is that action/behaviour on the part of teachers which helps a process to develop more quickly or more strongly. Teacher may use the following stimuli to keep the learners attentive in the class

2.1 Purposeful Movements

If a teacher teaches some concept standing at a fixed position, the learners get tired because they are looking into the eyes of the teacher from a particular angle for a long time It is desirable for a teacher to make a few purposeful movements in the class-may be either by changing his/her position while writing on the black board or explaining any concept or taking round of the class This may help in checking the non-attentive students especially those sitting on the backbenches. Too many movements by the teacher will act as destructors and must be avoided.

2.2 Purposeful Gestures

Movements of head. hands and body are called Gestures The proper use of gestures accelerates the process of inviting attention of the learners as gestures emphasize importance of the concept, events, indicate shapes of objects and also express emotions But gestures should also be used appropriately and with care Overuse and wrong use of gestures may rather disturb the learning process

2.3 Modulation in voice

Boredom prevails in the class if we are to listen to a person who is speaking in a low monotonous tone Change in pitch of the speaker disturbs the non-attentive listener and thus attention is invited back in the learning process Sometimes we bring modulation in our voice to highlight.emphasize the important part of the lesson Hence, it is desirable to change our speech pattern as per need of the hour

2.4 Focusing

It is observed that many times we focus on a particular aspect of the lesson This is done by teachers in a variety of ways. Some teachers

underline a word/statement on the blackboard, lay emphasis by using variety of gestures or make statements like 'Look here', 'This is very important' These acts fall in the category of focusing Focusing can be verbal, gestural or verbal-gestural focusing

2.5 Pausing

Some teachers stop speaking abruptly for a few seconds. This is not because that they have forgotten their content They do so purposefully When a teacher finds some students talking or whispering, the teacher does not say anything to the students Teacher does not want to scold the students He/she simply stops During the lecture/discussion of the teacher, some students especially sitting on the backbenches take advantage and go on whispering The moment teacher stops talking, the absence of teachers voice creates a sort of hindrance for the non-attentive students and thus they become attentive This behaviour of the teacher is called pausing Pausing is sometimes done after asking a question. Here, the purpose of giving a pause after asking a question is to give time to the students to think and then respond. Hence, it may be remembered that the purpose of pausing is twofold-one for inviting attention of the non-attentive learners and the second for giving time to students to think It is hoped that teachers may use the techniques of pausing effectively

3. Skill of Dealing With Pupil Response

The process of learning is supposed to be accelerated if it is continuously assessed by asking questions during or after development of the concepts. At the end of the lesson also a good teacher tries to satisfy his anxiety by testing whether learning of concepts has taken place or not In nutshell, it can be said that questioning is an essential aspect of teaching Questioning is also a skill It may be remembered that question is put before the whole class after recapitulating what has been taught Students should be given time to think and then any one student should be asked to reply Some teachers ask a question directly to any one student This is not desirable as

the student to whom the question has been asked all of a sudden was not mentally prepared and hence will become nervous and may not respond correctly even if he/she knows the answer Secondly when the question has been asked directly to one student, other students heave a sigh of relief and may stop applying their brain to respond Thus the process of thinking in the minds of rest of the students stops

Now let us see what happens when a teacher asks a question There may arise the following four situations:

- No response
- Partial correct/incomplete response
- Wrong response
- Correct response

In all these four situations, the teacher is to act in a responsible manner. The teacher is to study psychology of the students He/she is to act a facilitator or as a motivator He/she is to behave in a manner, which will encourage students to respond so as to participate more and more eagerly in the learning processes taking place in the classroom. Let's discuss in brief the above-mentioned four situations

3.1 No Response Situation

No response situation may be due to two factors (i) due to shy and introvert nature of the student and (ii) due to teacher. It is found that many students are shy and introvert They are lost in their own thoughts and in their own problems Such children need to be encouraged and motivated Positive aspect of their personality is to be highlighted and appreciated by using good words about them, about their dress, about their behaviour, about their very good performance in other fields. It may be remembered by the teachers that the so-called slow learners have some shining aspect of their personality That shining part of the personality is to be identified and nurtured to bring forward such introvert and slow learners We may not loose heart We may remind/recapitulate some earlier occasion of good

3.2 Partial Correct/Incomplete Response

There are many occasions when we get partially correct/incomplete response For example, if we ask what happens when a piece of magnesium wire burns, we may get the response that we get a white powder. This is incomplete answer We should not be satisfied by such incomplete answers. It would be desirable to use the positive reinforcers for getting the criterion response Positive reinforces can be of three types (i) +ve verbal like – 'O.K ', 'Yes', 'Fine', 'Good', 'Very good', 'Keep it Up'. I wanted this etc (ii) the Non-verbal like nodding, smiling, going near the pupil, patting etc. (iii) extra-verbal cues like 'um-um' etc After using the reinforcers for the correct part, we should seek further information from the students by asking questions like – 'What else', 'what more'? For example, in case of burning of a piece of magnesium wire, response will not be complete unless the students say that we get heat and light and a white powder of Magnesium-oxide Redirection may also be done if necessary Thus it is desirable to use the following three components in case of partially correct/incomplete response.

- Use of +ve Reinforcers
- Seeking Further Information
- Redirection

3.3 Wrong Response

Many time, students give wrong answers. In such a situation, we should try to identify reasons for the wrong response. We should not use negative reinforcers or scold the students Negative reinforcers are those acts/behaviours on the part of teachers, which retard the process of learning and also demotivate the students to participate in the class Their use should be restricted If at all, they are to be used, they should be used to the minimum extent The correct answer should be obtained from the students by using technique of redirection as mentioned earlier or teachers may tell the correct answer himself if it is not obtained from the students. Thus in

performance of the students and use +ve reinforces like – yes, 'You can do it', 'please try' etc

It is also equally possible that question asked by the teacher was not clear to the students Students could not understand the question or language of the questions Question was not specific Students fail to understand what to respond and what not to respond - Situation of uncertainly prevails and hence the problem In such a case, teachers are advised to analyze themselves Therefore, it would be in the fitness of things to repeat/rephrase the question Communication gap due to language is to be filled in It is observed that most of us loose temper, scold the students and frown on them in case of not getting the correct answer Such behaviours of teachers fall under the category of –ve reinforcers and should be used to the minimum extent. In such cases, teacher may prompt the student by asking simple related questions or even may give some hints to help the students in reaching the correct response. If all these efforts on the part of teacher fail to motivate the learner to respond, then the technique of 'redirection' may be applied i.e now the same question may be asked to some other student. The first student should not be asked to sit down otherwise the process of thinking will came to a stand still The second student may also be motivated/encouraged to respond If the second student also fails to respond even after prompting, then third student may be tried If third student responds correctly the first two students should be asked to repeat the answer Teacher may help the students to respond and reach the stage of criterion response Thus it can be agreed upon that the use of following components may be helpful in getting the response in case of 'No Response' situation

- Repeating/rephrasing the question
- Prompting
- Redirection
- Least use of -ve reinforcers

case of getting the wrong response use of the following two components is expected from the teachers.

- Least use of –ve Reinforcers
- Redirection

3.4 Correct Response

Most of us ask the students to sit down after getting the correct response When the student is giving response and especially the correct response, he/she waits very eagerly for recognition and appreciation of the correct response but some of us either do not pay attention to the correct response or accept the response without warmth If response of the students is not accepted with warmth and not appreciated appropriately, it may also demotivate them to respond Hence, it is desirable to recognize and appreciate the correct response of the students with warmth by using +ve reinforcers as mentioned earlier. It is the human weakness that each one of us expects good words about us on doing good work. Similarly, students also expect to be appreciated by their teachers in the class when they have responded correctly. But care must be taken that positive reinforcers are used appropriately. Overuse and wrong use of these reinforcers may be detrimental to learning.

Another important aspect to be remembered here is that we teachers should ensure whether the correct response given by students is just by guess/work or after giving a serious thought to the question In such a case we should try to increase critical awareness amongst the students by asking questions like 'Why' and 'How'? If the student has responded just by guesswork, he/she will not be able to respond correctly; otherwise we may get response of 'Why' and 'How' also Thus pupil participation in the class may be increased effectively by using the following components of the above-mentioned two skills.

- Purposeful Movements
- Purposeful Gestures
- Modulation in Voice
- Focussing
- Pausing
- Repeating/Rephrasing the Question
- Prompting by Asking Simple Related Questions
- Giving Hint About the Problem/Question
- Motivating/Encouraging Students
- Use of +ve Reinforcers
- Redirection
- Seeking Further Information
- Lease of use of –ve Reinforcers
- Increasing Critical Awareness

4. Conclusion

It is hoped that by using the positive reinforcers correctly and judiciously in our classrooms, at our homes, in our offices and in the society we can motivate our students, our own children, friends and colleagues and help in developing a congenial atmosphere in the society and produce better citizens in the society.

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Regional Institute of Education (N.C.E.R.T.) Ajmer

Training of KRPs in Teaching of Science and Technology from Class 6-10 for the States of U. P., Uttaranchal, H.P., J&K and Union Territory of Chandigarh (PAC-15.14)

Phase – II (12th – 16th January, 2004) for H.P., J&K, Uttaranchal and U.T. Chandigarh

Venue: RIE, Ajmer

APPROACH PAPER

Dr. V.P. Gupta

SCIENCE AND TECHNOLOGY

Science is a systematic study and knowledge of natural and physical phenomenon. National Curriculum Framework (NCF 2000) for school education describes science as the creative response to the curiosity and capacity to wonder. The national policy on education (1986) clearly emphasized the need of learning of science as a part of general education without compartmentalizing into its different disciplines i.e. why for the last seventeen years, science is being taught at the upper primary and secondary stage as a single discipline However, it is now being felt that technology (Science of mechanical and industrial arts) is increasingly influencing our quality of life Development of science has a direct bearing on technology and the society. The advancement of technology in all areas has made it imperative to impart such science education to children, which may clearly bring out the relationship between science, technology and society and help them prepare to live effectively in such a technology based society. Hence, a need was felt to include the component of technology in the science course at the upper primary and the secondary stage to emphasize upon the applications of various principles of Science to technology in our day-to-day life situations in view of the strong organic linkages between the two

TEACHING OF SCIENCE AND TECHNOLOGY

Teaching learning of science, because of its very nature, is to be different from other subjects Also learning of science & technology instead of promoting memorization should increase the spirit of enquiry, creativity, objectivity and aesthetic sensibility for making the learners good citizens. Science operates through its processes. Hence, science teaching is to be different from that of the other subjects. Here, question answer method will not serve the purpose Lecture method is never to be followed for teaching

of science at upper primary and secondary stage Thinking based upon keen and minute observations is to be generated among the learners Teaching learning of science needs to be characterized by focused emphasis on process of science which may consist of the following.

- Minute and careful observations
- Sensing of problems
- Making hypotheses
- Literature survey/consulting teachers or and friends
- Identification of a particular problem
- Experimentation for seeking solution
- Data collection and analysis
- Interpretation of Data
- Drawing inferences
- Testing and modification of hypotheses (in the light of experimental results)
- Limitations and scope for further studies

Besides, in our classroom teaching, we will have to perform activities for removal of misconceptions if any, develop and strengthen the concepts on the basis of seeing, doing and thinking.

OBJECTIVES

Keeping the above in view, this PAC approved programme has been undertaken by the institute on the request of the state governments of Uttaranchal, U.P., J & K, Himachal Pradesh and Union Territory of Chandigarh with the following objectives:

(i) to carry out content analysis of class 6-10 books published by NCERT and identity the concepts;

(ii) to develop experiments/activities on different concepts in In-house meetings, .

(iii) to train KRPs in conduction of **Science Experiments** with due emphasis on processes of science and development of values and

(iv) to make the KRPs aware about use of science in technology

In the light of objectives (i) and (ii) faculty members of DESM of the Institute have carried out content analysis of texts books and developed activity based materials related to the following chapters:

Sl. No.	Chapter	Class
1.	Acids, Bases and Salts	VII
2	Separation of substances	VI
3.	Coal and Petroleum	IX
4.	Metals and Non-Metals	VII & X
5.	Energy	VI to X
6	Light	VI to X
7	Magnetism and Electricity	VIII
8	Measurement	VI & IX
9.	Environment	VI to X
10	Cell	IX
11.	Organisation in the living world	VIII

Besides the above-mentioned topics, deliberations will also be held with the participants in the following areas·

- Science and Technology at upper primary and secondary stage in the light of NCF 2000 for school education
- Teaching of Science and Technology at Secondary Stage.
- Development of Values through science experiments and
- Evaluation and Grading
- Increasing Pupil participation

During the five-day training programme the participants will be oriented and allowed to perform a few exemplar activities related to concepts Discussions will be held about misconceptions, process of science and development of values implicit with various activities for development of concepts Rest of the activities suggested in the modules may be performed by KRPs in their institutes while carrying out training programmes for the science teachers. They are also expected to think of alternative activities keeping their local environment and resources in mind.

Also, each KRP is expected to develop at least three activities for better understanding and strengthening of concepts from any one topic of his/her choice and relate them to the latest technology wherever possible

Regional Institute of Education (N.C.E.R.T.) Ajmer

Phase – II

Training of KRPs in Teaching of Science and Technology from Class 6-10 for H.P., J&K, Uttaranchal States and U.T. Chandigarh

(12th January to 16th January, 2004)

Venue : RIE, Ajmer

TIME – TABLE

12.1.2004

9 00 to 9.30 a m	Registration	
9 30 a m	Inauguration	
	• Objectives	Dr V P Gupta,
	• Inauguration	Prof A B. Saxena Principal
10·30 a.m	Tea	
10 45 a.m.	Science and Technology at Upper Primary and Secondary Stage in the Light of NCF	Dr. V P. Gupta
11.45 a.m.	Environment	Dr.A. K .Mohapatra
1 15 p m.	Lunch	
2·15 p.m.	Teaching of Science and Technology	Dr. V P. Gupta
3:45 p m	Tea	
4·00 to 5:30 p.m.	Need Identification	Dr.V. P Gupta
	&	
	Group Formation	Dr. S. C Bhargava Dr R K. Parashar

13.1.2004

9.15 a .m.	Organisation in the Living World	Sh. J P. Narayan
10 45 a.m.	Tea	
11:00 a.m.	Measurement	Sh. V. P. Arya
12.15 p.m.	Separation of substances	Dr R K Parashar
1 15 p m.	Lunch	
2.15 p m	Separation of Substances	Mrs. Ruchi Verma Dr. V P Gupta Dr. Sukhvir Singh
3 45 p.m.	Tea	
4 00 to 5:30 p.m.	Group Work	Dr V P Gupta Dr A. K Mohapatra Dr R K Parashar

14.1.2004		
9 15 a.m.	Science, Technology, Evaluation & Grading	Prof A B Saxena
10.45 a.m.	Tea	
11.00 a.m.	Acids, Bases and Salts	Dr. V.P. Gupta
12 15 p.m.	Group Work	Dr. V.P Gupta Dr. R K. Parashar Dr.A K.Mohapatra
1·15 p.m.	Lunch	
2·15 p.m	Work and Energy	Dr H. C Jain
3:45 p m	Tea	
4:00 to 5 30 pm.	Magnetism & Electricity	Dr S. V. Sharma
15.1.2004		
9 15 a m	Coal and Petroleum	Dr V.P. Gupta
10·45 a m.	Tea	
11 00 a.m	Food Production & Management	Sh. J P. Narayan
12:30 p.m.	Group Work,	Dr V.P. Gupta Sh J P Narayan Dr S.V. Sharma
1.15 p.m.	Lunch	
2 15 p.m.	Light	Dr H. C Jain
3·45 p.m.	Tea	
4:00 to 5·30 pm	Metals & Non-Metals	Dr. R. K. Parashar Dr. S. C Bhargava
16.1.2004		
9.15 a.m	Group Work	Dr. V.P. Gupta Dr. Sukhvir Singh Dr R. K Parashar Mrs. Ruchi Verma
10:45 a m.	Tea	
11:00 a m.	Development of Values at Secondary Level through Science Experiments	Dr. V.P. Gupta Dr R K Parashar
12.15 p m	Increasing Pupil Participation	Dr V P Gupta
1·15 p m.	Lunch	
2 15 p m	Finalization of group work	
3 30 p.m.	Valedictory • Presentation of group work • KRPs' Views • Principal's Address	
4 30 p m.	Disbursement of T A /D.A to KRPs	

Training of KRPs in Teaching of Science and Technology From Class 6 – 10 for the States of U.P., Uttaranchal, H.P., J&K and Union Territory of Chandigarh(PAC 15.14)

Phase – II (12th - 16th January, 2004) for H.P., J&K, Uttaranchal & U.T. Chandigarh

List of participants

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Programme Coordinator: Dr. V. P. Gupta, Reader in Chemistry
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A) Diode

Q) How did you infer it?

A) When component was connected, no current was passing. On changing the terminals, current was passing. I do not know about the side of biasing i e., which side is forward biased or reverse biased. Forward bias is giving the current whereas reverse bias does not do the same.

Q) Why current is not passing in reverse biased diode?

A) It becomes backward biased. Therefore, it does not pass any current.

Q) What is backward biasing?

A) No response

Student No. 4

A) Capacitor

Q) On what basis?

A) It does not allow flow of current. First, it charges fully

Q) Make it clear?

A) Initially, it does not become zero

BOX No. 10.

Student No. 1

Q) What did you find in Box Number 10? (Common question put to all the students interviewed)

A) Conductor

Q) On what basis

A) On increasing the rheostat, the reading of voltage was increasing The value of current was also increasing.

Q) Do you think that voltage increases with current?